I-10 and Baseline Road Service Traffic Interchange

Feasibility Analysis

Prepared for

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1.0 Introduction

The Interstate 10 (I-10) and Baseline Road Traffic Interchange (TI) Feasibility Analysis is being conducted by the Maricopa Association of Governments (MAG) to evaluate the feasibility of improving intersection and corridor operations. The study Planning Partners include the town of Guadalupe (Guadalupe), the city of Phoenix (Phoenix), the city of Tempe (Tempe), the Federal Highway Administration (FHWA), the Arizona Department of Transportation (ADOT), and MAG.

1.1 Study Overview

MAG I-10/I-17 Spine Corridor Master Plan (The Spine Study), completed March 2018, analyzed long-term strategies to improve mobility along the 31-mile corridor between the I-10/SR-202L (San Tan and South Mountain Freeways) System TI and the I-17/SR-101L (North Stack) System TI. The Spine Study recommended a reconfiguration and modernization of the I-10 Baseline Road TI. The proposed concept is a Diverging Diamond Interchange (DDI) configuration to improve safety and capacity of the TI. The Spine Study also recommended the construction of a bicycle and pedestrian bridge over the freeway as a bicycle alternative to traveling on Baseline Road through the TI. The paths to be connected by the bridge pass through Phoenix, Tempe, and Guadalupe.

The purpose of this feasibility study is to evaluate the TI at I-10 and Baseline Road and to perform conceptual evaluation of different TI configurations, with one being the DDI recommended in the Spine Study. Multi-modal travel safety and operations will be key factors for the conceptual evaluation, including accommodating active transportation travel through the TI, including bicycles, pedestrians, and shared-use micro-mobility devices.

Vision Zero is a traffic safety policy that takes an ethical approach towards achieving safety for all road users. Tempe is the first Vision Zero city in Arizona and is currently preparing a Vision Zero Action Plan. Engineering safety countermeasures from the Plan will be fully considered in this feasibility study.

1.2 Study Area

Baseline Road is a major arterial road serving approximately 60,000 vehicles per day. Land use within the extents of the Study Area is primarily commercial and includes access to Arizona Mills Mall just east of the TI with I-10.

The existing I-10 and Baseline Road TI is located within Tempe. The nearest arterial intersections along Baseline Road are 48th Street to the west and Priest Drive to the east. The nearest TIs along I-10 are the I-10 and US-60 System TI located immediately to the

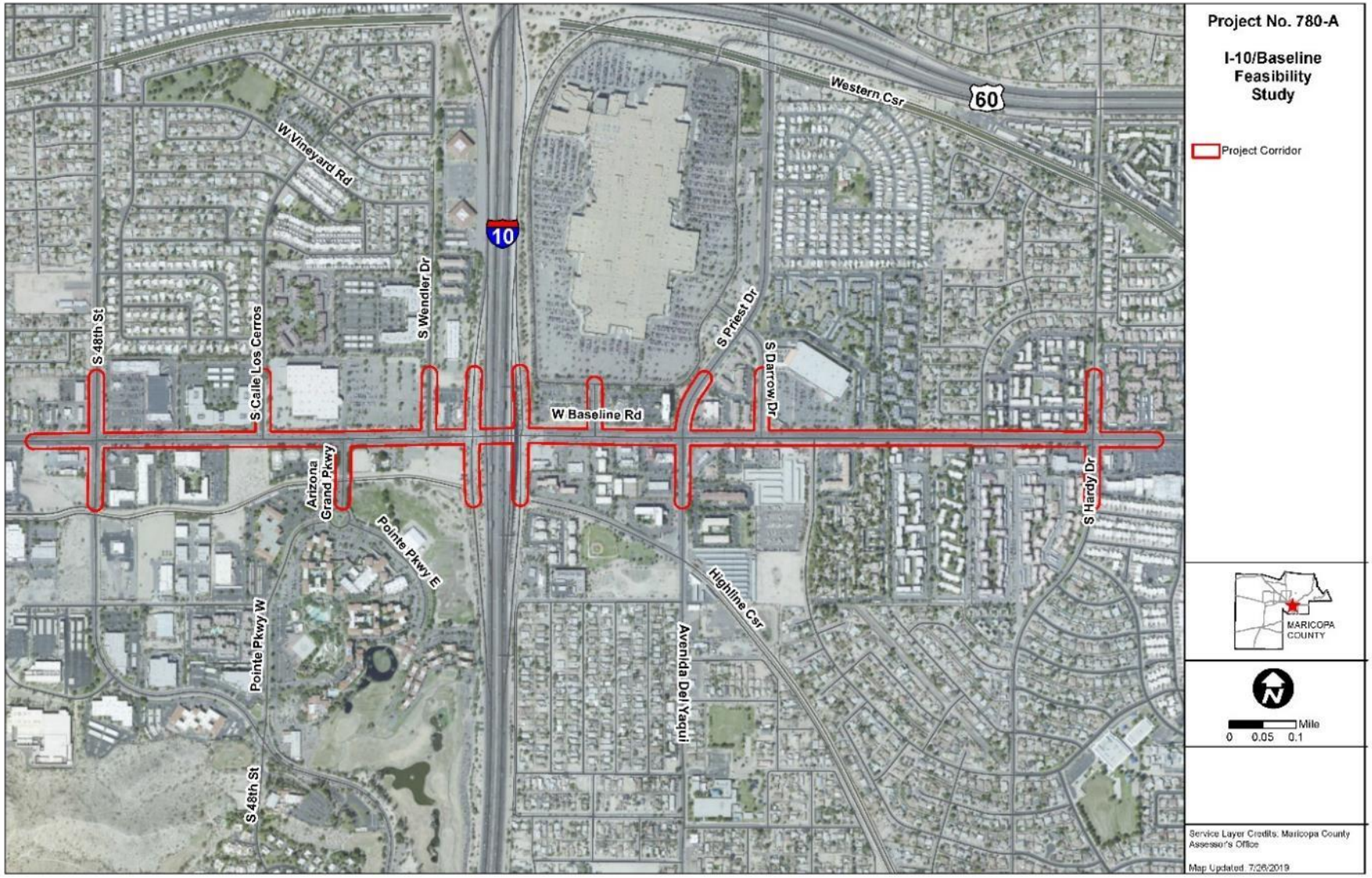
north and the I-10 and Elliot Road TI to the south. The I-10 Baseline Road TI is currently configured as a standard diamond interchange.

The Study Area, as shown in ***Figure 1***, consists of the 1.5-mile corridor along Baseline Road between 48th Street to the west and Hardy Drive to the east. The Study includes the following intersections on Baseline Road:

- South 48th Street
- South Calle Los Cerros Drive
- Arizona Grand Parkway
- South Wendler Drive
- I-10 Eastbound Ramps
- I-10 Westbound Ramps
- Arizona Mills South
- South Priest Drive
- South Darrow Drive
- Hardy Drive

The study area identified in ***Figure 1*** was used to analyze crash history, existing conditions, and operational analysis. The existing conditions were analyzed at all the intersections within the Study Area. Through discussion with Planning Partners, it was determined to limit the proposed improvements to those which directly benefited the TI. Consequently, the proposed improvement limits along Baseline Road are Calle Los Cerros to the west and Priest Drive to the east.

Figure 1 – Study Area Map



2.0 Study Approach

2.1 Background Information

This section summarizes known and available plans and studies completed during the past 10 years within the Study Area. Relevant improvements and plan recommendations from the previous studies are included. Documents related to the studies are available upon request.

2.1.1 ADOT I-10 Broadway Curve: I-17 (Split) to Loop 202 (San Tan Freeway) (Ongoing)

ADOT, in partnership with FHWA and MAG, is studying and designing preliminary concepts for improvements to the I-10 Broadway Curve area between I-17 (Split) and SR-202L (San Tan Freeway). Proposed improvements include: adding general purpose and high occupancy vehicle lanes; adding a collector-distributor road system; substantially modifying the I-10/SR-143/Broadway Road connections and the I-10/US-60 (Superstition Freeway) connection; improving drainage; constructing bridges; improving the Intelligent Transportation Systems (ITS) facilities; building retaining and sound walls and pedestrian bridge crossings; utility relocations; and other related work. The study will integrate with the MAG Spine Study discussed in **Section 2.1.4** and the I-10 Near-Term Improvements Study discussed in **Section 2.1.6**.

2.1.2 ADOT Five-Year Transportation Facilities Construction Program (June 2019)

ADOT developed the 2020-2024 Current Five-Year Transportation Facilities Construction Program (Program) to provide a framework for developing projects over the next five-year period. The purpose of the Program is to account for the spending of funds on projects ready to advertise within two years of the Program or to establish implementation plans for projects still in preparation. The Program identifies plans to widen the I-10 mainline from the I-17 split to SR-202L in Chandler and includes improvements at the Broadway Curve to help traffic flow more efficiently.

2.1.3 Phoenix Capital Improvement Program 2019-24 (June 2019)

Phoenix approved the 2019-2024 Capital Improvement Program (CIP) in June 2019, which provides the planned construction program by project and details the sources of funds for the projects. The purpose of the CIP is to account for the spending of funds on projects programmed to begin in the next five years. The CIP identifies street improvements on 48th Street from Baseline Road to South Point Parkway. The CIP also identifies the South Central Light Rail Extension as terminating at the intersection of Baseline Road and Central Avenue. The extension is outside of this Study's limits, but construction will have a significant impact on traffic.

2.1.4 MAG I-10/I-17 "Spine" Corridor Master Plan (March 2018)

MAG, along with FHWA and ADOT, launched a study to develop a Corridor Master Plan for the I-10 and I-17 corridor, which serves as the backbone ("Spine") for transportation in the metropolitan Phoenix area. The Spine Study is evaluating the full range, long-term solutions of transportation modes and concepts to identify the best multimodal solutions and will identify how to best use the allocated funds to achieve the greatest benefit to the region. The I-10/I-17 Spine Corridor is 31 miles, beginning at the I-17/SR-101L (North Stack) interchange, continues through the I-10/I-17 (The Split) interchange, and end at the I-10/SR-202L (Pecos Stack) interchange. The Spine Study recommends reconstructing the TI at Baseline Road and I-10 into a DDI, as well as widening the I-10 for additional through and high-occupancy vehicle (HOV) lanes.

2.1.5 MAG Road Safety Assessment at the Intersection of Baseline Road and Interstate 10 (May 2017)

MAG, in cooperation with ADOT and Tempe, conducted a Road Safety Assessment (RSA) for the intersection of Baseline Road and I-10. The RSA focuses on identifying short, intermediate, and long-term solutions that improve the safety of all road users. The intersection is ranked #23 on MAG's High Crash Intersection list. The RSA noted several safety concerns related to roadway geometry, signal timing, traffic signals and lighting, signing and marking, and maintenance. Short-term improvements include signal timing coordination, replacing street signs, re-defining lane assignments, and performing landscape maintenance. Intermediate-term improvements include reconstructing the southeast corner ramp to American with Disabilities Act (ADA) compliance, improving street lighting, and retrofitting pedestrian push buttons for ADA compliance. Long-term improvements include updating the geometry at Wendler Drive and updating signal heads.

2.1.6 ADOT I-10 Near-Term Improvements Study (August 2016)

ADOT, in cooperation with FHWA, has initiated a Design Concept Report (DCR) and environmental study to evaluate near-term freeway capacity improvement options on I-10 from the SR-143 to the SR-202L (San Tan Freeway). The study is meant to develop and evaluate near-term freeway improvement options to accommodate the growing traffic demand in the corridor. Initial concepts for improvements include: reconfigure the I-10/SR-143 TI and I-10/US-60 TI ramps at the Broadway Curve to separate ramp traffic from mainline traffic, eliminating the current weaving patterns; and construct additional general-purpose travel lanes in each direction between US-60 and Ray Road, and one general-purpose travel lane on inbound I-10 between Baseline Road and Ray Road. The study will integrate with the MAG Spine Study discussed in **Section 2.1.4** and the I-17 Near-Term Auxiliary Lanes Study discussed in **Section 2.1.7**.

2.1.7 ADOT I-17 (Black Canyon Freeway) Near-Term Auxiliary Lanes Study (2015)

ADOT, in cooperation with FHWA, initiated a Project Assessment (PA) and environmental study to evaluate near-term freeway operational improvements on I-17 from the I-10/I-17 "Split" Interchange to 19th Avenue. The study will evaluate the addition of auxiliary lanes between successive entrance and exit ramps to improve operations by providing additional length for traffic weaving movements in the corridor. The study will integrate with the MAG Spine Study discussed in **Section 2.1.4** and the I-10 Near-Term Improvements discussed in **Section 2.1.6**.

2.1.8 Phoenix Transportation 2050 (August 2015)

The Transportation 2050 plan is a 35-year citywide street and transit improvement plan and addresses a wide array of concerns expressed by residents who drive, bike, walk, and ride transit services. Transportation 2050 supersedes the previous transit plan, known as T2000, and places additional emphasis on street needs which will complement the increase in transit services. The plan identifies a Bus Rapid Transit system on Baseline Road slated to begin by 2020, and the east route will run from Central Avenue to I-10.

2.1.9 Tempe Transportation Master Plan (January 2015)

The goal of the Tempe Transportation Master Plan (TMP) is to provide a multi-modal transportation guide for the City that includes short term (2020) and long term (2040) recommendations and supports the General Plan 2040. The TMP identifies many characteristics of Baseline Road, from current traffic counts to demographics to pedestrian and bicycle facilities. The TMP lists several 2020 intersection safety improvements along Baseline Road, including Priest Drive and Hardy Drive. The TMP also identifies lane reductions on Baseline Road from Kyrene Road to SR-101L to add bicycle lanes and a tree line. Though outside of this Study's limits, construction will have a significant impact on traffic.

2.1.10 Tempe General Plan 2040 (December 2013)

Tempe updated its General Plan in 2013 to the General Plan 2040, which holds the community's vision for the future and is an expression of how the community wants to grow and change over the next thirty years. The Circulation System Chapter guides the further development of a citywide multi-modal transportation system integrated with the City's land use plans. Emphasis is placed on "seeking the 20-minute city," or a city with a vibrant mix of commercial and residential establishments within a one-mile walking distance, a 4-mile bike ride, or a 20-minute transit ride. Numerous pedestrian, bicycle, and transit facility improvements are listed, including expanding the bicycle path/lane on the Baseline Road corridor through lane reductions and street improvements.

2.2 Existing Conditions

This section covers the existing conditions for Baseline Road within the Study Area extents, including the existing transportation network, existing turning movement counts at the intersections, the average daily traffic along each segment of the corridor, and the existing traffic signal timing plans.

2.2.1 Existing Transportation Network

Baseline Road is a six-lane arterial road with posted speeds of 45 mph along the extents of the Study Area. The through lanes are divided by a two-way left-turn lane (TWLTL) for most of the corridor, with median islands present in locations to separate dedicated left turn lanes. Commercial and industrial businesses line the corridor, including Arizona Mills Mall on the northeast corner of I-10 and Baseline Road. Apartments and single-family subdivisions are found east of Arizona Mills Mall.

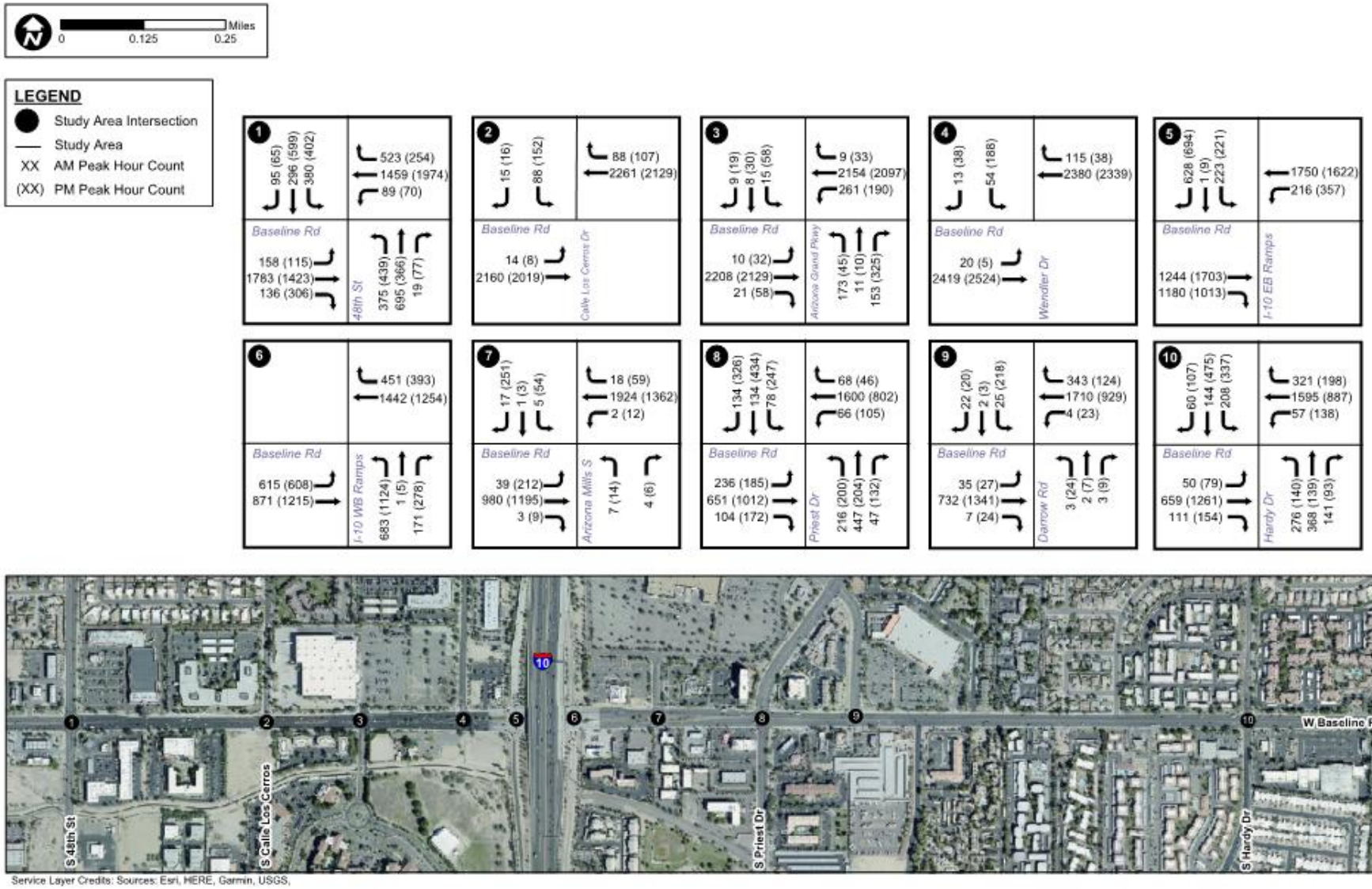
Baseline Road is the last east-west roadway before South Mountain and a terminus point of nearly all north-south roads west of the I-10. A few exceptions extend into residential communities at the base of the mountain. 48th Street is the most notable, as it becomes South Pointe Parkway south of Baseline Road and connects through to Elliot Road. South Pointe Parkway is a two-lane residential road with posted speeds of 25 mph and is not designed to carry heavy through traffic.

Between 48th Street and Hardy Drive, Baseline Road touches four jurisdictions: Phoenix, Tempe, Guadalupe, and ADOT. Phoenix maintains the intersection of 48th Street and Baseline Road. Tempe maintains Baseline Road from 48th Street to Hardy Drive, while ADOT maintains the entrance and exit ramps to I-10 as well as the bridge overpass. Guadalupe's northern-most limits are between the I-10 and Avenida del Yaqui on the south side of Baseline Road.

2.2.2 Existing Turning Movement Counts

Existing turning movement count data was collected at nine Study Area locations on April 11, 2019, with count data for 48th Street collected on April 16, 2019. Counts were collected for 12 hours: from 6 a.m. to 10 a.m. and from 11 a.m. to 7 p.m. The 2019 peak hour turning movement counts collected for the Study Area are shown on ***Figure 2***. More detailed traffic count data, including vehicle classification counts, is included in **Appendix A**.

Figure 2 – Peak Hour Turning Movement Counts



2.2.3 Average Daily Traffic (ADT)

The traffic counts described in **Section 2.2.2** were used to derive 24-hour traffic volumes along the corridor. Typically for the region, arterials have 72% of their ADT in the vicinity of their interchanges with a freeway in the 12-hours when the counts were observed. Consequently, the I-10 ramps were scaled to 24 hours by assuming that the counted 12-hour volumes were equivalent to 72% of the ADT. The ADTs for the remaining intersections were first scaled the same way, and then adjusted using volume balancing to ensure traffic volumes were consistent throughout the corridor. This resulted in the counted volumes being equivalent to 72.1% to 80.6% of those intersections' ADT. The increased percentage of counted volumes can be attributed to the commercial land uses along Baseline Road on the east side of the I-10.

Future ADT was forecasted using the most recent MAG Travel Demand Model, following the procedures described in **Section 2.5.1**. ***Figure 3*** shows the existing and future ADT for the Study Area corridor. Existing ADT is shown in black; future ADT is shown in red.

Figure 3 – Existing and Future ADT

Existing daily traffic volumes along Baseline Road within Study Area extents along the corridor; ADT ranges between approximately 32,490 and 72,568 vehicles per day.

2.2.4 Existing Active Transportation Facilities

2.2.4.1 Existing Connectivity

Connected active transportation networks provide access to destinations for a variety of users by promoting the opportunity to complete trips by walking, bicycling, or using transit. The first and last mile of transit trips is an important component of an active transportation network. The *2019 MAG Active Transportation Plan* provides a framework for encouraging and providing safe connectivity for all users.

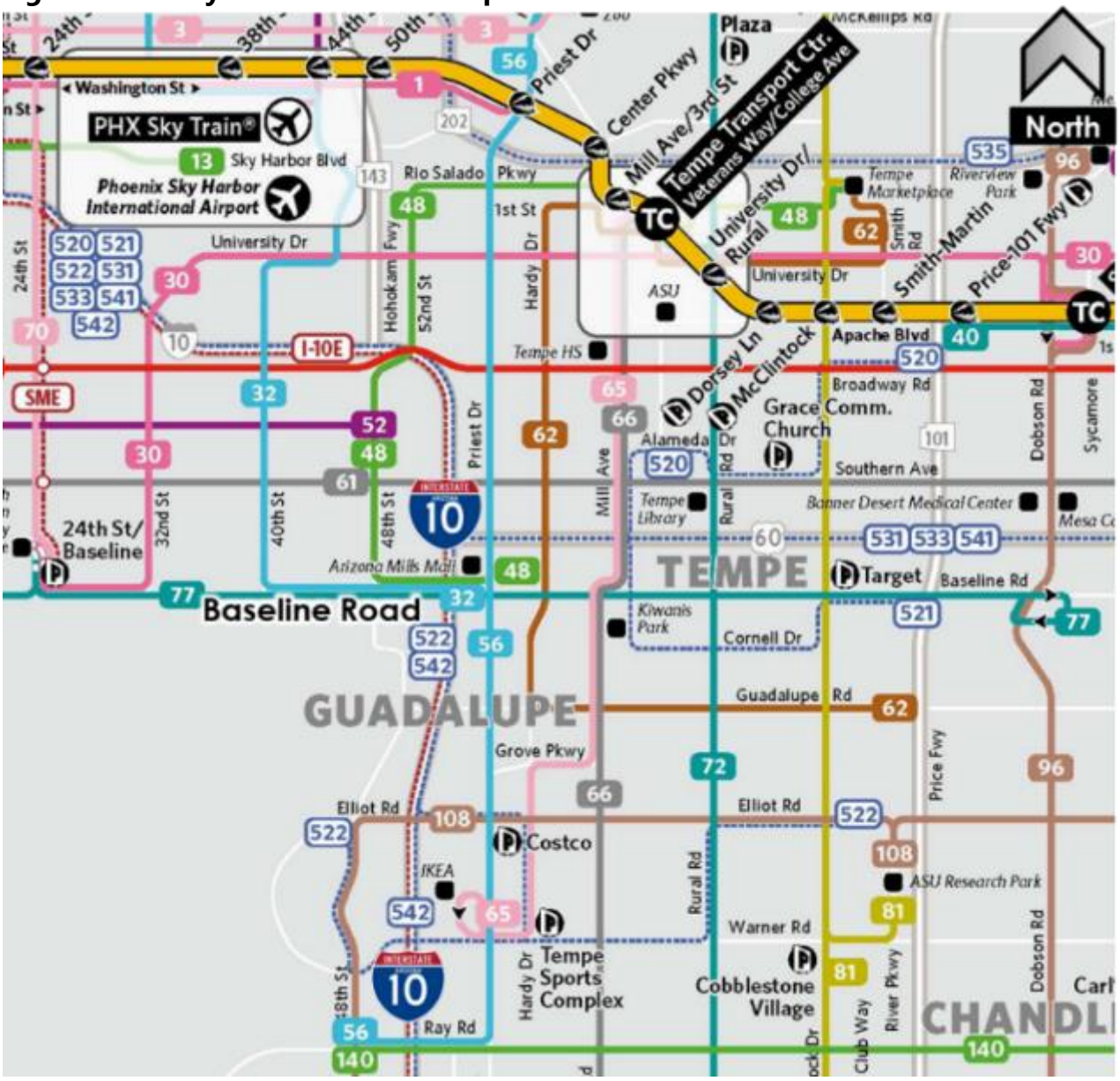
Figure 4 illustrates the Valley Metro network map. Bicycle and pedestrian connectivity maps are included in ***Figure 5*** and ***Figure 6***. These maps illustrate the bike and shared-use path designations per Tempe and Phoenix. The nearest pedestrian I-10 crossings to

Baseline Road are located one mile north at the Southern Avenue underpass and one mile south at the Guadalupe Road overpass bridge. Southern Avenue has sidewalks on both sides of the roadways and no dedicated bike lanes. There are no sidewalks or bike lanes on Guadalupe Road between Point Parkway and Calle Sahuaro except for the bridge itself, where there is a sidewalk on one side of the bridge. The segment between Point Parkway and the bridge has sharrow pavement markings indicating a shared lane for vehicles and bicycles. ***Figure 7*** and ***Figure 8*** depict the existing active transportation facilities within the study area.

2.2.4.2 Transit Facilities

Phoenix has plans for a future Bus Rapid Transit (BRT) route on Baseline Road ending at 48th Street. A future BRT route further east on Baseline Road into Mesa should be considered in future projects. The Baseline Road corridor is served directly by the Valley Metro bus service. There are several bus routes on Baseline Road with multiple bus stops within the study area. Bus Route 77 serves the entire study area, and Route 48 and Route 32 are accessed at the Arizona Mills South bus stop and at the bus stops to the west of I-10. There are additional route connections at 48th Street (Route 48), Priest Drive (Route 56), and Hardy Drive (Route 62). According to the Valley Metro Route 77 schedule, the bus system operates from approximately 4:00 AM to 12:30 AM on weekdays depending on the stop. The bus arrives every 30 minutes.

Figure 4 – Valley Metro Network Map



Most of the bus stops have shelters, while a few have benches only. The locations of the bus stops are depicted on ***Figure 7*** and ***Figure 8***.

Figure 5 – Existing Bicycle Connectivity

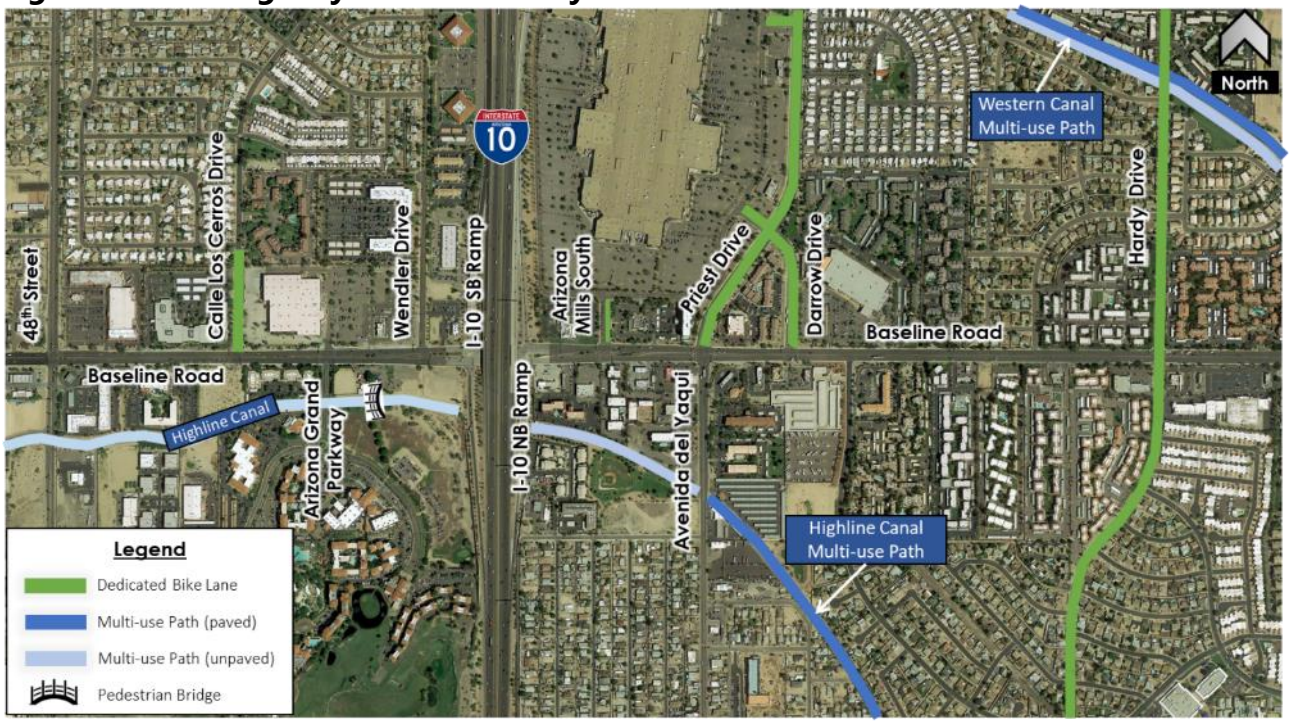


Figure 6 – Existing Pedestrian Connectivity

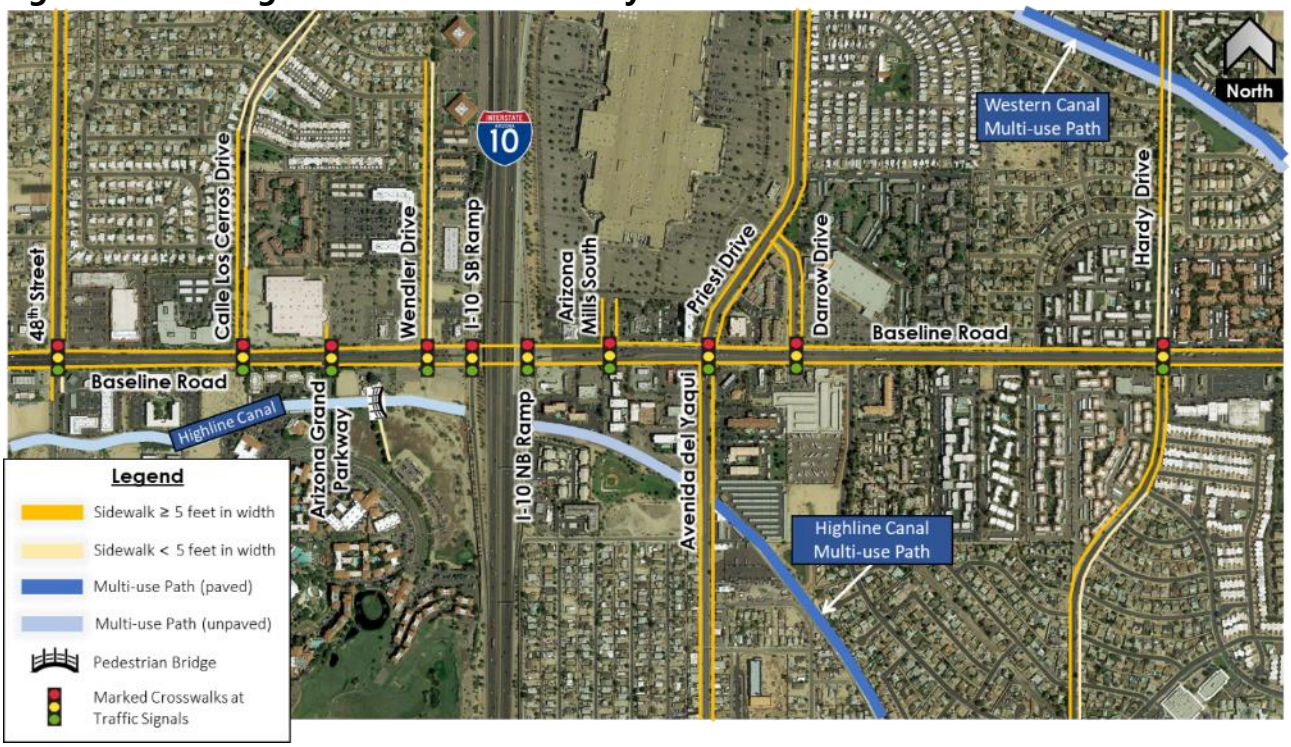


Figure 7 – Existing Active Transportation Facilities- 48th Street to I-10

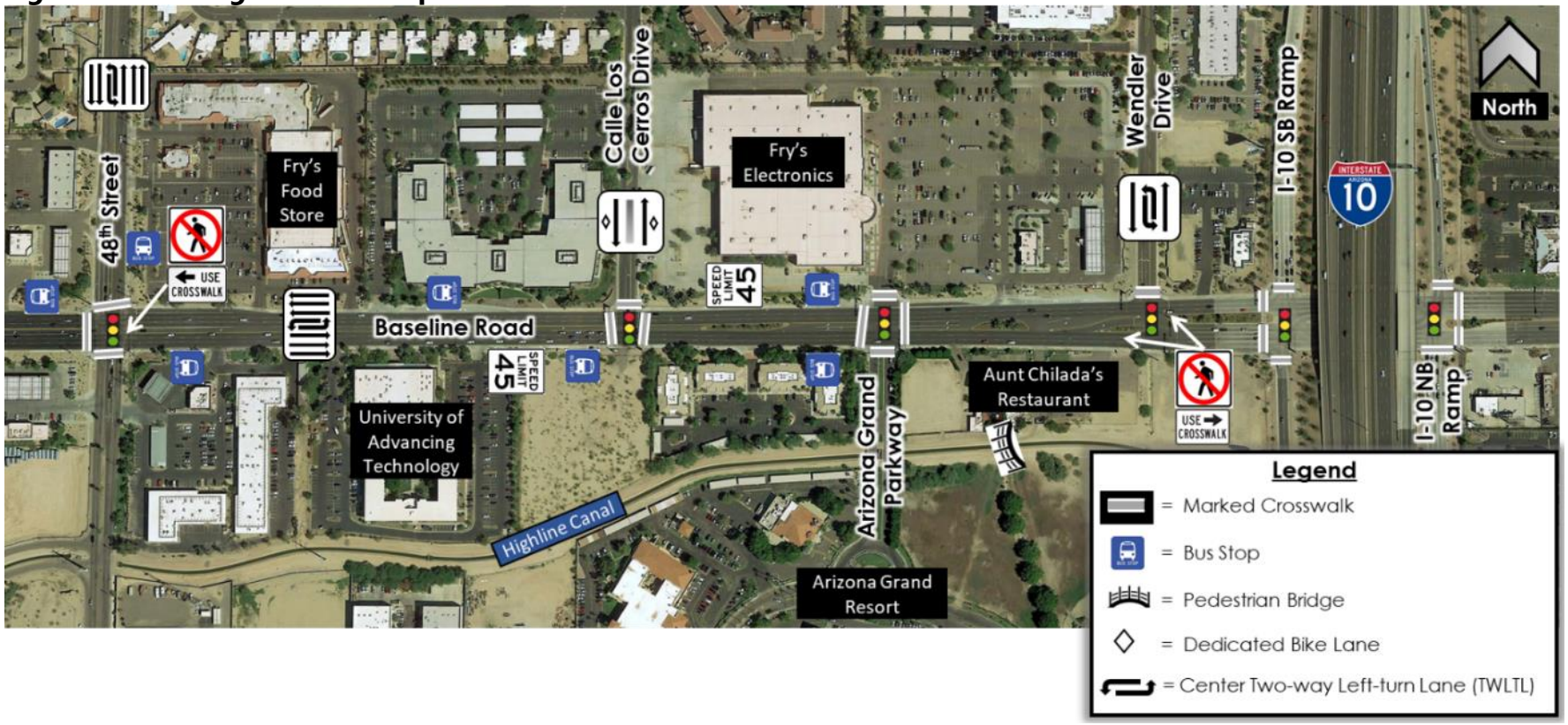


Figure 8 – Existing Active Transportation Facilities- I-10 to Hardy Drive

2.2.4.3 Bicycle and Pedestrian Facilities

Shared-Use Paths and Trails

Near the study area, there are two designated shared-use paths: Western Canal and Highline Canal. Neither of these shared-use paths currently have pedestrian/bicycle crossings over or under I-10. The Western Canal crossing will be constructed as part of the ADOT I-10 Broadway Curve improvements.

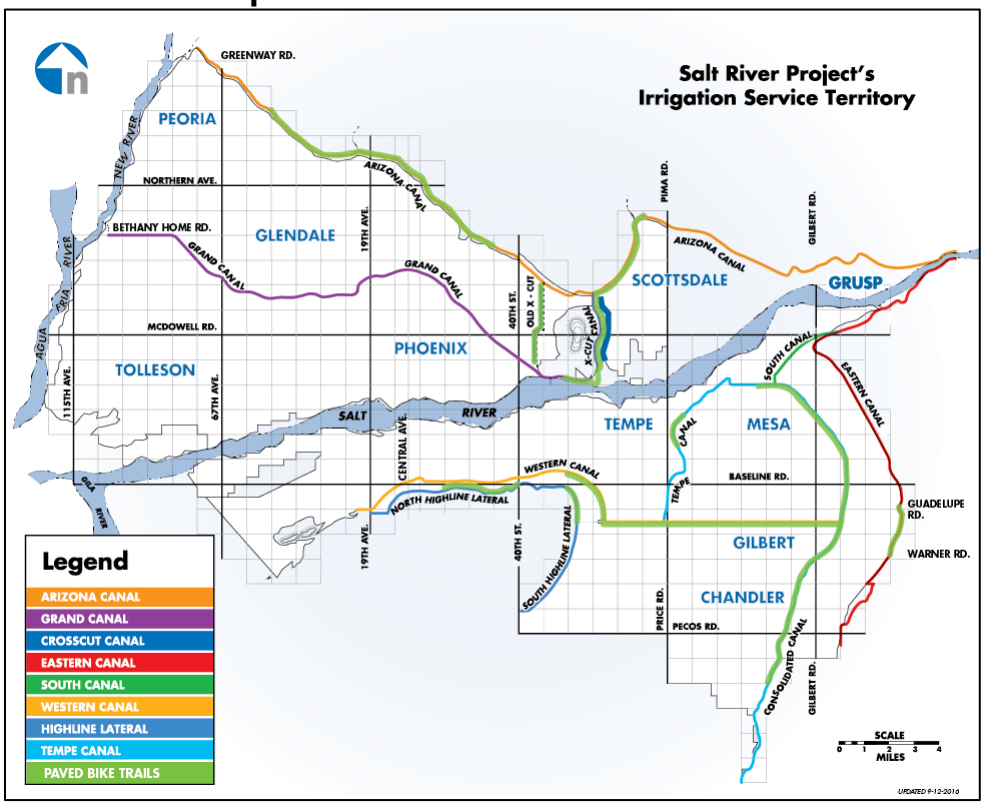
The location of the shared-use paths within the study area are previously depicted in ***Figure 5*** and ***Figure 6***. The Western Canal is part of the Maricopa County Sun Circle and Maricopa Trails. This important corridor extends from 35th Avenue within Phoenix and east into Tempe. In Tempe, a paved shared-use path is provided beginning at Arizona Mills and heads southeast past Baseline Road through the Kiwanis Park, through the Ken McDonald Golf Course, and then east into Gilbert.

Within Phoenix, the Highline Canal is located between the Western Canal and South Mountain. A paved, shared-use path is located along this canal corridor between Central Avenue and 40th Street. At 46th Street, the Highline Canal proceeds southeast into Tempe and Guadalupe, and wraps back across I-10 into Phoenix. East of Avenida del Yaqui, the Highline Canal shared-use path is paved through Guadalupe and into Tempe. A photo of the paved portion of the Highline Canal shared-use path at Avenida del Yaqui is shown in ***Figure 9***.

Figure 9 – Highline Canal Shared-Use Path

Figure 10 depicts the Salt River Project's (SRP) canal map.

Figure 10 – SRP Canal Map



Bike Lanes

There are currently no dedicated bike lanes on Baseline Road within the project limits. As depicted in ***Figure 5***, there are dedicated bike lanes on Priest Drive, Darrow Drive and Hardy Drive. There is a break in connectivity on Priest Drive (Avenida del Aqui) with no bike lanes south of Baseline Road. There are also dedicated bike lanes for a short distance on Calle Los Cerros Drive.

Sidewalks

There are existing sidewalks on both sides of Baseline Road with widths varying from 5 to 8 feet within the study limits. The sidewalk connectivity is previously depicted in ***Figure 6***. The sidewalks are in generally good condition. The south sidewalk on Baseline Road heaves near the I-10 interchange as shown on the photo in ***Figure 11***. The field review also observed that the existing driveways on Baseline Road do not meet cross slope requirements per current ADA standards. Examples of the driveways are shown in ***Figure 12***.

Crosswalks and Enhanced Crossings

Marked crosswalks are provided at each of the signalized intersections on Baseline Road as depicted previously in ***Figure 7*** and ***Figure 8***. The east leg of the Baseline Road/48th Street intersection does not have a marked crosswalk. R9-3 signs (no pedestrian crossing symbol) and R9-3b plaques ("Use Crosswalk") are posted on the east leg to discourage crossings. The crosswalk counts reveal that there are pedestrians and bicyclists who cross the east leg despite the posted signs and lack of marked crosswalk. The Baseline Road/Wendler Drive intersection only has a marked crosswalk on the north leg with no marked crosswalks crossing Baseline Road. The R9-3 sign and R9-3b plaque are posted to discourage Baseline Road crossings at this intersection. The Baseline Road/Arizona Mills South intersection does not have a marked crosswalk on the west leg, but the R9-3 and R9-3b signs are posted. The crosswalk counts reveal that there are pedestrians and bicyclists who cross the west leg despite the posted signs and lack of marked crosswalk. ***Figure 13***, ***Figure 14*** and ***Figure 15*** depict the legs without crosswalks. As shown in the photo in ***Figure 15***, the R9-3 sign at Arizona Mills South is faded and needs replaced.

There are no enhanced or midblock crosswalks on Baseline Road within the study area. There are two pedestrian refuge islands provided on Baseline Road on each side of I-10 at the marked crosswalks on Baseline Road. ***Figure 16*** and ***Figure 17*** provide photos of the existing pedestrian refuge islands.

Vehicles were observed stopping in the crosswalks at the Baseline Road and I-10 interchange as depicted in ***Figure 18***. This is caused by the queuing on Baseline Road through the intersections and by the heavy right-turn movements.

Figure 11 – Poor condition of sidewalk on south side of Baseline Road near I-10 Interchange

Figure 12 – Driveways on Baseline Road (cross slope does not meet current ADA standards)

Figure 13 – Baseline Road and 48th Street – No Crosswalk on East Leg

Figure 14 – Baseline Road and Wendler Drive – No Crosswalks on Baseline Road

Figure 15 – Baseline Road and Arizona Mills South – No Crosswalk on West Leg

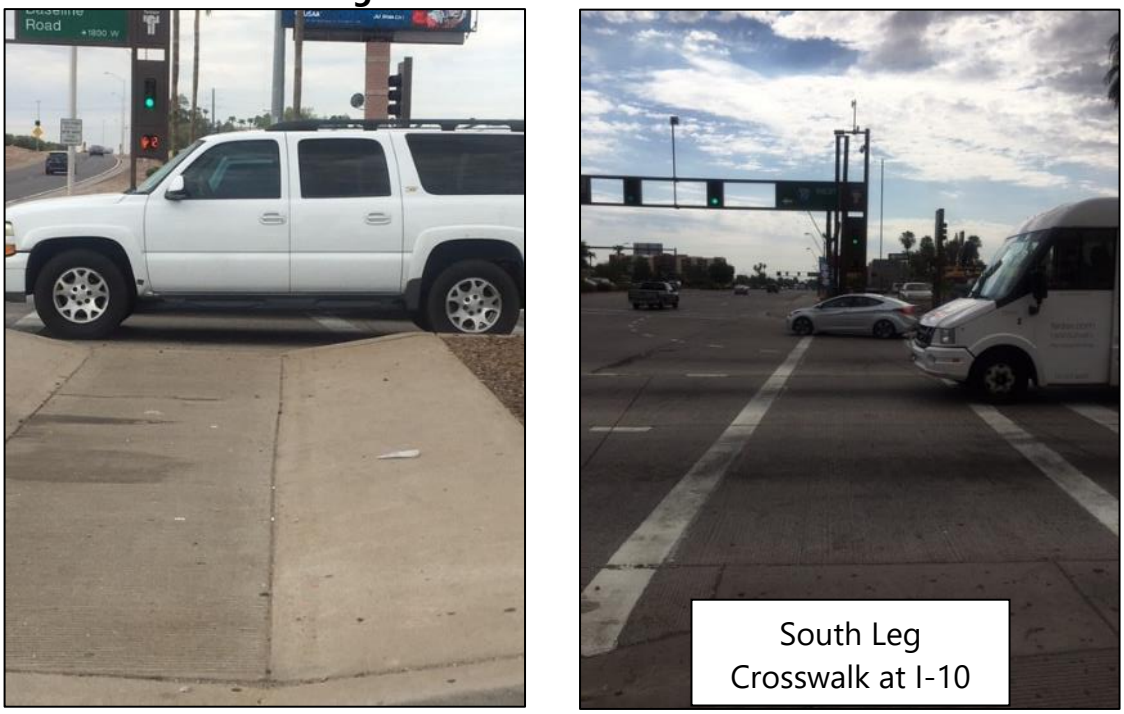
Figure 16 – Existing Pedestrian Refuge Island on Baseline Road at the I-10 Northbound Ramp

East Leg Crosswalk on Baseline Rd at I-10 NB Ramp

East Leg Crosswalk Refuge Island on Baseline Rd at I-10 NB Ramp

Figure 17 – Existing Pedestrian Refuge Island on Baseline Road at the I-10 Southbound Ramp

Figure 18 – Vehicles blocking the crosswalks at the I-10 Baseline Road Interchange



2.2.5 ADA and PROWAG Considerations

Sidewalks, street crossings and other elements of the public right-of-way need to be designed to provide accessibility for all users. The ADA Accessibility Guidelines (ADAAG) are developed and updated by the United States Access Board to provide design guidelines in ADA compliance. The purpose of the design guidelines is to ensure access to the built environment for people with disabilities. The most recent guidelines are referred to as the *2010 ADA Standards for Accessible Design*.

The Access Board has also drafted the *Public Right-of-Way Accessibility Guidelines (PROWAG)* to focus primarily on sidewalk and street crossing design within the public right-of-way. The purpose of the guidelines is to ensure that access for persons with disabilities is provided wherever a pedestrian way is newly built or altered to provide equitable convenience, connection, and safety to pedestrians with disabilities.

The existing driveways on Baseline Road do not meet the most recent ADA and PROWAG guidelines. Multiple ramps at the existing signalized study intersections are also not up to date with the most recent standards, specifically not having truncated domes. The existing pedestrian refuge islands and corresponding pedestrian push buttons on Baseline Road at the I-10 ramps do meet current ADA and PROWAG standards. Any new design or alterations to these existing pedestrian facilities shall incorporate the most recent ADA and PROWAG guidelines.

2.3 Stakeholder Engagement

Meeting materials for the following meetings, including agenda, presentation, and summary, are provided in **Appendix B**.

2.3.1 Kickoff Meeting

A kickoff meeting was held on April 3, 2019 in the Tempe Bus Conference Room. Representatives from Guadalupe, Tempe, ADOT, FHWA, MAG, and the design team attended the meeting. During this meeting, Planning Partners were able to note issues and considerations that may affect the Study Area and feasibility of design. Major takeaways from the meeting include:

- Baseline Road is the highest volume corridor in Tempe and has a correspondingly high crash rate. Pedestrian and vehicular safety are a serious concern;
- Tempe's Vision Zero focuses on reducing the number of crash-related pedestrian deaths, and pedestrian and bicycle considerations are needed for the area;
- Right-of-way constraints in the corridor are tight;

- Improvements to the I-10 Broadway Curve are estimated to begin in Spring 2020 and any improvements to the I-10 Baseline Road TI need to tie into the plans; and
- Only portions of the Spine Study are currently funded. A possible design alternative to the TI that could be completed in sections and phases might assist with funding concerns.

2.3.2 Phoenix Partner Meeting

The Phoenix partner meeting took place on April 16, 2019, in the Phoenix City Hall, 5th Floor 5 East Conference Room. Representatives from Phoenix, MAG, and the design team attended the meeting. The meeting purpose was to discuss Phoenix study goals and objectives and identify project area opportunities, constraints, and additional pertinent studies or projects. Major takeaways from the meeting include:

- Pedestrian and bicycle safety is a significant concern along the corridor;
- It is not anticipated that the I-10 bridge over Baseline Road would require reconstruction;
- Access management may become a concern along the corridor; and
- Design Baseline Road to accommodate Bus Rapid Transit (BRT) as Phoenix's BRT limits have not yet been determined and may extend to the project area.

2.3.3 Workshop

The planning workshop meeting took place on September 3, 2019, in the MAG Ironwood conference room. Representatives from Guadalupe, Phoenix, Tempe, ADOT, FHWA, MAG, and the design team attended the meeting. The meeting purpose was to review existing and future no-build conditions analysis and identify alternatives to investigate. In addition to an optimized no-build, improvements identified to be investigated included:

- Diverging Diamond Interchange (DDI)
    - Modify Spine Study alternative by reducing the space between the crossovers;
    - Ensure that cyclists can be accommodated; and
    - Modify adjacent intersections of Wendler and Arizona Mills.
- Standard Diamond
    - Provide dedicated lane for east to south movement, but accommodate a pedestrian crossing;
    - Modify adjacent intersections of Wendler and Arizona Mills; and
    - Optimize signal timings and movements.
- Improve pedestrian facilities along the corridor.

2.3.4 Tempe Stakeholder Meeting

The Tempe partner meeting took place on October 22, 2019, in the Tempe Bike conference room. Representatives from Tempe, MAG, and the design team attended the meeting. The meeting purpose was to review potential corridor improvements and goals for Tempe. Major takeaways from the meeting include:

- Proposed development on the southwest corner of Calle Los Cerros will construct a right turn pocket and requires the existing signal to remain;
- Tempe is not interested in increasing the number of through lanes through the TI;
- Realign Wendler Drive to intersect opposite Arizona Grand;
- Increase storage length under the bridge to 350' per lane; and
- Further investigation of access at Arizona Mills intersection access.

2.3.5 Guadalupe Partner Meeting

The Guadalupe partner meeting took place on November 21, 2019, in the MAG Palo Verde conference room. Representatives from Guadalupe, MAG, and the design team attended the meeting. The meeting purpose was to review potential corridor improvements and goals for Guadalupe. Major takeaways from the meeting include:

- Consolidate driveway access along Baseline Road;
- Avoid shaded structures along the Highline Canal Path due to social issues; and
- Guadalupe will defer to Tempe and Phoenix regarding TI improvements.

2.3.6 Phoenix Partner Meeting

An additional Phoenix partner meeting took place on November 21, 2019, in the Phoenix City Hall Traffic Management Center conference room. Representatives from Phoenix, MAG, and the design team attended the meeting. The meeting purpose was to review potential corridor improvements and goals for Phoenix. Major takeaways from the meeting include:

- Ensure reviewed alternatives do not prohibit future BRT and
- Concerns utilizing ramp through movement for I-10 incident management.

2.3.7 Stakeholder Meeting

The stakeholder meeting took place on February 24, 2020, in the MAG Ironwood conference room. Representatives from Guadalupe, Phoenix, Tempe, ADOT, MAG, and the design team attended the meeting. The meeting purpose was to review proposed alternatives. Major takeaways from the meeting include:

- Further investigation is necessary to determine the number of total right-of-way acquisitions within the corridor;
- Standard diamond and DDI alternatives are feasible;
- A preferred alternative will not be selected at this stage; and
- Additional alignments should be considered for Wendler Drive to preserve the most usable area in parcels.

2.4 Crash Analysis

Data for crashes occurring in the Study Area between January 1, 2014 and December 31, 2018 was obtained from ADOT's Accident Location Identification Surveillance System (ALISS) database. ***Figure 19*** shows the crash heat map for the Study Area. ***Table 1*** summarizes the annual distribution of crashes by the severity of the crash. Additional active transportation crash analysis is included in **Section 2.4.1**.

Figure 19 – Crash Heat Map

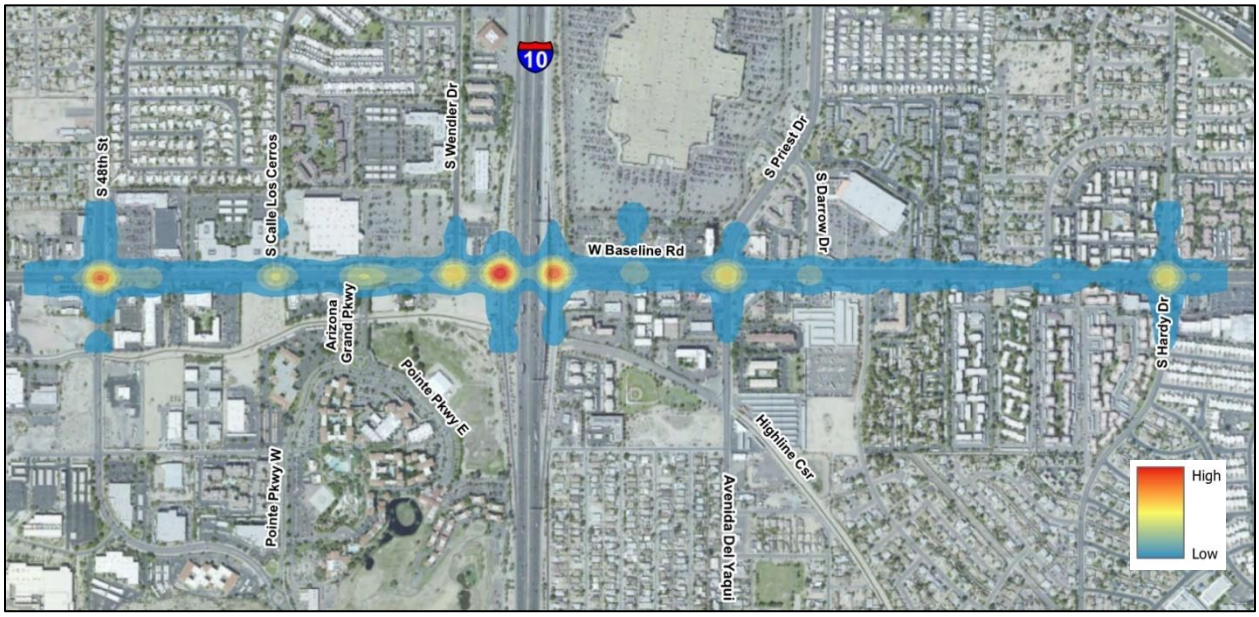


Table 1 – Annual Crash Distribution						
Year	**No Injury**	**Possible Injury**	**Suspected Minor Injury**	**Suspected Serious Injury**	**Fatal**	**Total**
2014	231	58	37	6	1	**333**
2015	280	51	40	3	0	**374**
2016	261	46	36	5	0	**348**
2017	278	49	48	4	0	**379**
2018	281	55	39	3	1	**379**
Total	**1,331**	**259**	**200**	**21**	**2**	**1,813**
Percent	**73.4%**	**14.3%**	**11.0%**	**1.2%**	**0.1%**	**100%**

Table 2 summarizes the crash severity for intersections in the Study Area; ***Table 3*** summarizes segments. Intersection spacing in the Study Area is generally less than 1,000 feet; therefore, there are very few segments as most crashes are included in the intersection influence area.

Table 2 – Crash Severity by Intersection						
Intersection	**No Injury**	**Possible Injury**	**Suspected Minor Injury**	**Suspected Serious Injury**	**Fatal**	**Total**
48th Street	223	50	26	6	0	**305**
Calle Los Cerros Drive	93	18	13	1	0	**125**
Arizona Grand Parkway	108	23	18	0	0	**149**
South Wendler Drive	121	32	9	0	0	**162**
I-10 Southbound Ramps	211	24	13	0	0	**248**
I-10 Northbound Ramps	169	30	25	1	0	**225**
Arizona Mills South	65	12	7	0	0	**84**

Table 2 – Crash Severity by Intersection						
Intersection	**No Injury**	**Possible Injury**	**Suspected Minor Injury**	**Suspected Serious Injury**	**Fatal**	**Total**
South Priest Drive/Avenida del Yaqui	124	15	22	3	1	**165**
South Darrow Drive	51	12	17	3	1	**84**
Hardy Drive	107	28	27	7	0	**169**
Total	**1,272**	**244**	**177**	**21**	**2**	**1,716**

Table 3 – Crash Severity by Segment						
Segment	**No Injury**	**Possible Injury**	**Suspected Minor Injury**	**Suspected Serious Injury**	**Fatal**	**Total**
48th St to Calle Los Cerros	13	2	4	0	0	**19**
Darrow Drive to Hardy Drive	46	13	19	0	0	**78**
Total	**59**	**15**	**23**	**0**	**0**	**97**

An examination of the crash trends within the Study Area shows:

- The intersection of 48th Street had the most crashes over the five-year period, accounting for 17% of all crashes in the corridor (305 of 1,813 total crashes);
- The intersections at the northbound and southbound ramps account for 12.4% and 13.7% of all crashes in the corridor, respectively; and
- The number of crashes at an intersection or segment is independent of exposure.

Crash data was analyzed and compared to the 2018 Arizona Motor Vehicle Crash Facts (Crash Facts) published by ADOT. An analysis of the collision manner through the Study Area indicated a higher percentage of crashes involving pedalcyclists, unknown, and motor vehicles in transit (multivehicle crashes) than the 2018 urban area averages presented in the Crash Facts. Categories exceeding the statewide average are shown in bold, red, italicized text. These percentages are presented in ***Table 4***.

Table 4 – First Harmful Event			
First Harmful Event	Baseline Road		% Urban Areas Statewide
	Number	%	
Collision with Motor Vehicle in Transit	1,663	***91.7%***	80.5%
Overturning	4	0.2%	0.8%
Collision with Pedestrian	15	0.8%	1.4%
Collision with Pedalcyclist	19	1.0%	1.1%
Collision with Animal	0	0.0%	0.3%
Collision with Fixed Object	38	2.1%	7.6%
Collision with Non-fixed Object*	4	0.2%	4.3%
Vehicle Fire or Explosion	1	0.1%	0.1%
Other Non-collision**	1	0.1%	0.2%
Unknown	68	***3.8%***	3.7%
Total	1,813	100%	100%

*Includes Collision with Parked Vehicles, Trains, Railway Vehicles, and Work Zone Equipment

**Includes Vehicle Immersion, Jackknife, and Cargo Loss or Shift

Bold, red, italicized text denotes values over urban areas statewide

An examination of the collision trends along the corridor shows:

- Collisions with pedalcyclists was just under the urban area average; however, there were additional bicycle crashes not coded as the first harmful event;
- 38 crashes involved a cyclist or pedestrian; four of these crashes involved a non-motorist but were coded as "motor vehicle in transport," "curb," and "not reported";
- The two fatal crashes both involved pedestrians; one was coded as a multi-vehicle crash, the other as a fixed object crash:
  - One fatality occurred at Darrow Drive where the vehicle struck a pedestrian and
  - One fatality occurred near Priest Drive. A vehicle was leaving a business and the driver lost control of the vehicle, striking several curbs, a wall, and sign onsite. It continued northbound across a landscaped area and struck a pedestrian near the driveway.

An analysis of the collision manner through the Study Area indicated that the corridor has a higher percentage of left turn, rear end, and sideswipe crashes than the statewide averages presented in Crash Facts. Note that the designations U-turn and angle by type were recently added; these are not included in earlier years. These percentages are presented in ***Table 5***. Categories exceeding the statewide average are shown in bold, red, italicized text.

Table 5 – Manner of Collision in Multi-Vehicle Crashes

Collision Manner	Baseline Road		% Statewide
	Number	%	
Angle	243	13.7%	14.5%
Left Turn	319	***18.0%***	16.5%
Rear End	854	***48.2%***	44.4%
Head-On	12	0.7%	1.7%
Sideswipe (same)	279	***15.8%***	15.5%
Sideswipe (opposite)	6	0.3%	1.4%
U-Turn	2	0.1%	0.2%
Other*	45	2.5%	5.2%
Unknown	10	0.6%	0.7%
Total	1,770	100%	100%

Bold, red, italicized text denotes values over statewide averages
*Includes rear to rear, rear to side, pedestrian, and pedalcyclist

An examination of the collision trends along the corridor shows:

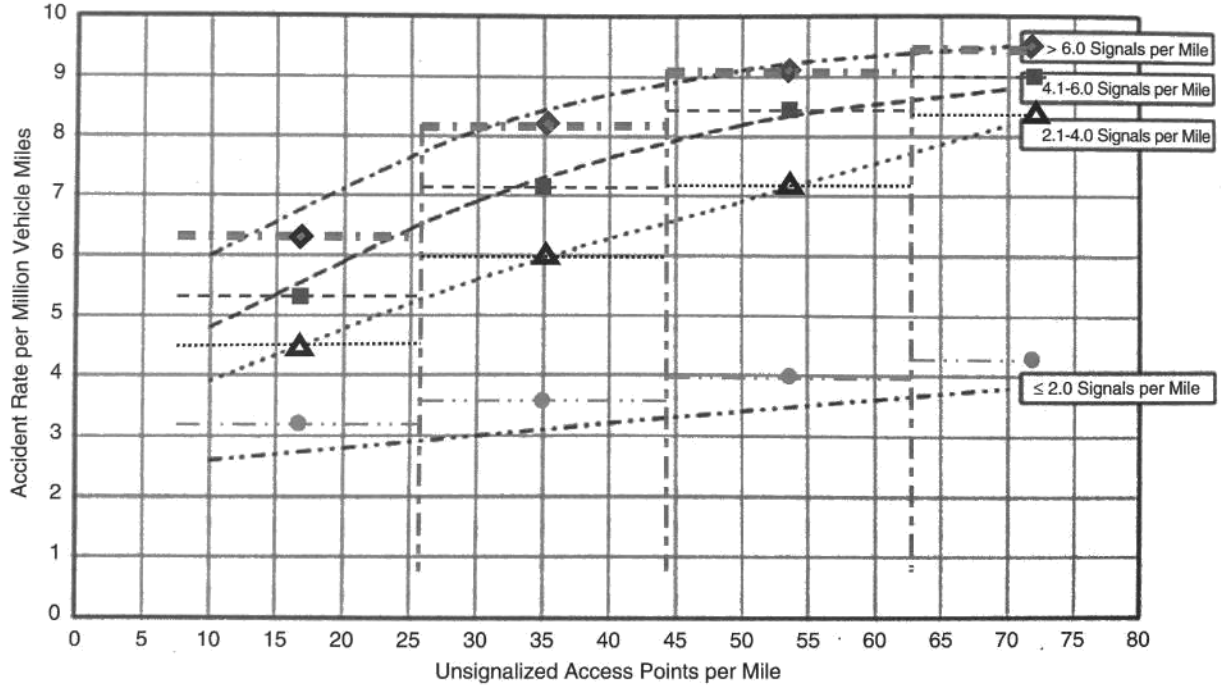
- A majority of the incapacitating crashes, as well as one of the two fatal crashes, were left-turn crashes.
  - Note that 86 of the 319 (27.0%) left-turn crashes occurred at intersections with protected-only left-turn traffic signal phasing.

A high percentage of rear end collisions is typically indicative of congestion. The occurrence of numerous left-turn crashes at traffic signals with protected-only left-turn phasing is indicative of driver non-compliance. This behavior may be indicative of congestion/delay as well.

A holistic review of the Study Area crash history suggests that access management plays a key role in its safety performance. Within the 1.5-mile Study Area, there are 10 signalized

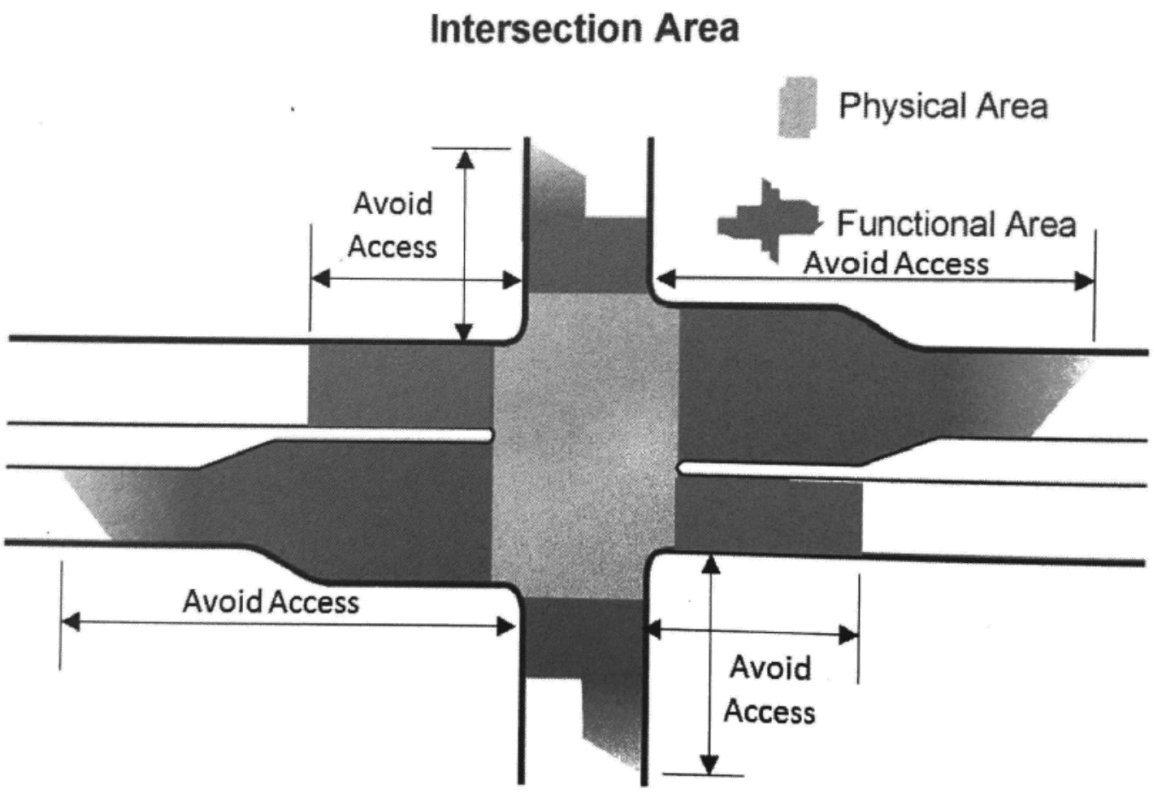
intersections, as well as other stop-controlled intersections and driveways. There are nine signalized intersections in the 1-mile segment from 48th Street to Darrow Drive as well as 27 unsignalized access points. The Transportation Research Board (TRB) Access Management Manual (Access Management Manual), Second Edition, explains the effect signal density and unsignalized access density have on crash rates. A summary figure from the Access Management Manual is included as ***Figure 20***. Note, the maximum value expressed is >6 signals per mile. This curve corresponds to an accident rate per million vehicle miles of about 8 with 27 unsignalized access points in a mile. The Study Area, including the portion east of Darrow Drive to Hardy Drive, has a rate of 13.6.

Figure 20 – TRB Exhibit 15-3: Effect of signal density and unsignalized access density on average crash rates in urban and suburban areas



In addition to the number of traffic signals, traffic signal spacing may influence crash patterns. The Access Management Manual recommends that no access should be provided within the functional area of an intersection; the concept of functional area is illustrated in ***Figure 21***. Excluding required queuing distances, the upstream functional distance is 405 feet with a perception-reaction time of 1.5 seconds and a posted speed of 45 mph. Similarly, the ideal downstream functional distance per based on acceleration Exhibit 14-11 in the Access Management Manual is 740 feet. Within the Study Area, traffic signals lie within the functional area of another signalized intersection; for example, the Wendler Drive intersection is approximately 340 feet from the I-10 southbound ramp intersection. This may contribute to the crash rate.

Figure 21 – TRB Exhibit 14-1 Functional area in which access should be avoided



Predictive analysis was performed for a few intersections using the Highway Safety Manual (HSM) methodology via the Interactive Highway Safety Design Model (IHSDM) and is summarized in ***Table 6***. Each intersection analyzed had a positive potential for safety improvement (PSI), meaning it does not perform as well as similarly configured intersections with similar exposure. This may be attributable in part to access management.

Table 6 – Summary of HSM Analysis for Evaluation Period			
Intersection	**Total Expected**	**Total Predicted**	**PSI**
Arizona Grand	147.8	42.0	105.8
Arizona Mills	78.7	25.3	53.4
Priest Drive	156.7	29.0	127.7

2.4.1 Active Transportation Safety Analysis

Pedestrians, bicyclists or other active forms of transportation are the most vulnerable users of the transportation network because they cannot protect themselves from the speed and mass of a motor vehicle, and they often have minimal or no outer protection. Therefore, crash prevention is an important component for the safety of pedestrians and bicyclists. The 2019 MAG Active Transportation Plan provides a toolbox for promoting safety for the active transportation users.

Vision Zero is a traffic safety policy that takes an ethical approach towards achieving safety for all road users. Tempe is the first Vision Zero city in Arizona. Engineering safety countermeasures from the Plan will be incorporated into configurations evaluated for this feasibility study.

2.4.1.1 Crash Summary

Five years of ALISS crash data were obtained from ADOT's Safety Data Mart database for the study intersections. As part of the active transportation baseline conditions, the bicycle and pedestrian crashes were summarized. The pedestrian and bicycle crashes per study intersection are summarized in ***Table 7***. The "K" crashes involve a fatal injury, and the "A" crashes involve a suspected serious injury.

The total crashes by injury severity within the study area are summarized in ***Table 8*** for bicycle crashes and ***Table 9*** for pedestrian crashes. ***Table 10*** summarizes the crashes by vehicle movement for all of the study area, and ***Table 11*** summarizes all the pedestrian and bicycle crashes by light condition.

During the five-year period from 2014 to 2018, there were 21 bicycle crashes and 17 pedestrian crashes reported within the study area. The intersections with the highest number of bicycle and pedestrian crashes are the Baseline Road/Hardy Drive intersection (7 total crashes), Baseline Road/48th Street intersection (6 total crashes), and Baseline Road/Darrow Drive intersections (5 total crashes).

Most of the crashes occurred at an intersection with a pedestrian or bicyclist in the crosswalk, and 23 of the 38 crashes were reported as involving a turning vehicle and four were pulling out of a driveway. There was one serious injury crash involving a bicycle in 2017 at the Baseline Road/Calle Los Cerros Drive intersection. There were two fatal crashes involving a pedestrian: one in 2014 at the Baseline Road/Darrow Drive intersection and one in 2018 near the Baseline Road/Priest Drive intersection. The fatal crash near Baseline Road/Priest Drive involved a driver losing control of their vehicle exiting a car wash, jumping a curb, and hitting the pedestrian in the sidewalk. The fatal crash at Darrow Drive

involved two vehicles, one making a left-turn, and the pedestrian was crossing in a crosswalk. Of the 38 crashes, 23 occurred during the daylight, one during dawn, two during dusk, ten during dark (lighted), and two during dark (not lighted).

Table 7 – Pedestrian and Bicycle Crash Summary

Year		Intersection of Baseline Road &													Total
		48th Street	Calle Los Cerros Drive	Arizona Grand Parkway	Wendler Drive	I-10 SB Ramp	I-10 NB Ramp	Arizona Mills South	Lindon Lane	Priest Drive	Darrow Drive	Beck Avenue	Terry Lane	Hardy Drive	
2014	All Bicycle	3	1	0	0	0	0	0	0	0	0	0	2	1	**7**
	All Pedestrian	0	0	0	0	0	0	0	0	0	2	0	0	1	**3**
	Pedestrian & Bicycle K & A	0	0	0	0	0	0	0	0	0	1	0	0	0	**1**
2015	All Bicycle	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**
	All Pedestrian	0	0	0	0	0	0	0	0	0	1	2	0	2	**5**
	Pedestrian & Bicycle K & A	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2016	All Bicycle	0	1	0	0	0	0	0	0	1	0	0	0	0	**2**
	All Pedestrian	0	0	0	0	1	0	0	1	0	0	0	0	0	**2**
	Pedestrian & Bicycle K & A	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2017	All Bicycle	1	1	0	1	0	0	1	0	0	0	1	0	3	**8**
	All Pedestrian	1	0	0	0	1	0	1	0	0	1	0	1	0	**5**
	Pedestrian & Bicycle K & A	0	1	0	0	0	0	0	0	0	0	0	0	0	**1**
2018	All Bicycle	1	0	0	1	0	0	0	0	0	1	0	0	0	**3**
	All Pedestrian	0	0	0	0	0	0	0	0	2	0	0	0	0	**2**
	Pedestrian & Bicycle K & A	0	0	0	0	0	0	0	0	1	0	0	0	0	**1**
TOTAL	All Bicycle	**5**	**3**	**0**	**2**	**0**	**1**	**1**	**0**	**1**	**1**	**1**	**2**	**4**	**21**
2014-2018	All Pedestrian	**1**	**0**	**0**	**0**	**2**	**0**	**1**	**1**	**2**	**4**	**2**	**1**	**3**	**17**
	Pedestrian & Bicycle K & A[1]	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**3**

There was one serious injury crash involving a bicycle in 2017 at the Baseline Road/Calle Los Cerros Drive intersection. There were two fatal crashes involving a pedestrian: one 2014 at the Baseline Road/Darrow Drive intersection and one in 2018 near the Baseline Road/Priest Drive intersection.

Table 8 – Bicycle Crash Severity– Entire Study Area

Crash Severity	Bicycle Crash Severity					
	2014	2015	2016	2017	2018	TOTAL
Fatal	0	0	0	0	0	**0**
Serious Injury	0	0	0	1	0	**1**
Non-incapacitating Injury	3	1	2	3	0	**9**
Possible Injury	4	0	0	3	2	**9**
No Injury	0	0	0	1	1	**2**
TOTAL	**7**	**1**	**2**	**8**	**3**	**21**

Table 9 – Pedestrian Crash Severity – Entire Study Area

Crash Severity	Pedestrian Crash Severity					
	2014	2015	2016	2017	2018	TOTAL
Fatal	1	0	0	0	1	**2**
Serious Injury	0	0	0	0	0	**0**
Non-incapacitating Injury	3	2	1	3	0	**9**
Possible Injury	0	2	1	1	1	**5**
No Injury	0	0	0	1	0	**1**
TOTAL	**4**	**4**	**2**	**5**	**2**	**17**

Table 10 – All Pedestrian & Bicycle Crashes by Vehicle Movement (2014 to 2018)

Crashes by Vehicle Movement			
Vehicle Movement	**Pedestrian**	**Bicycle**	**Total**
Through Vehicle	3	6	**9**
Left-turning Vehicle	6	3	**9**
Right-turning Vehicle	5	9	**14**
Pulling out of Driveway	2	2	**4**
Other/Unknown	2	0	**2**
TOTAL	**18**	**20**	**38**

Table 11 – All Pedestrian & Bicycle Crashes by Light Condition (2014 to 2018)

Light Condition	Pedestrian	Bicycle	Total
Daylight	9	14	**23**
Dawn	0	1	**1**
Dusk	1	1	**2**
Dark-Lighted	6	4	**10**
Dark-Not Lighted	1	1	**2**
Dark-Unknown Lighting	0	0	**0**
Unknown	0	0	**0**
Total	**17**	**21**	**38**

2.4.1.2 Existing Pedestrian and Bicycle Counts

Turning movement counts were collected for this project at the ten study intersections from 6:00 AM to 10:00 AM and from 11:00 AM to 7:00 PM and were provided in 15-minute increments. The traffic counts at the Baseline Road/48th Street intersection were collected on Tuesday April 16, 2019, and the other nine study intersections were collected on Thursday, April 11, 2019. As part of the turning movement counts, the pedestrian and bicycle counts were recorded in the crosswalks. The crosswalk pedestrian and bicycle counts during the peak hour of the crosswalk are summarized in ***Figure 22*** for each study intersection. The crosswalk counts during the peak hours of the intersection based on vehicular volume are summarized in ***Figure 23*** for each study intersection. The Baseline Road/Priest Drive intersection had the highest pedestrian and bicycle crosswalk volume with 121 pedestrians and bicyclists per hour (total of all legs) recorded from 4:15 PM to 5:15 PM. The intersection ranking based on pedestrian and bicycle crosswalk volumes is summarized in ***Table 12*** for the peak hour of the crosswalk and in ***Table 13*** for the PM peak hour of the intersection based on vehicular volume.

Table 12 – Intersection Ranking of Crosswalk Volume during Peak Hour of Crosswalk

INTERSECTION	PEAK HOUR OF CROSSWALK (HOUR BEGIN)	CROSSWALK VOLUME PER HOUR (TOTAL OF ALL LEGS)		
		TOTAL	PEDESTRIAN	BICYCLE
Baseline Road & Priest Drive	4:15 PM	121	110	11
Baseline Road & Arizona Mills South	6:00 PM	87	79	8
Baseline Road & Hardy Drive	3:00 PM	84	78	6
Baseline Road & Darrow Drive	9:00 AM	73	67	6
Baseline Road & 48th Street	12:30 PM	55	49	6
Baseline Road & I-10 NB Ramp	8:45 AM	35	32	3
Baseline Road & I-10 SB Ramp	8:30 AM	31	26	5
Baseline Road & Arizona Grand Parkway	2:00 PM	27	24	3
Baseline Road & Calle Los Cerros Drive	12:30 PM	25	17	8
Baseline Road & Wendler Drive	12:15 PM	14	8	6

Table 13 – Intersection Ranking of Crosswalk Volume during PM Peak Hour of Intersection

INTERSECTION	PM PEAK HOUR OF INTERSECTION (HOUR BEGIN)	CROSSWALK VOLUME PER HOUR (TOTAL OF ALL LEGS)		
		TOTAL	PEDESTRIAN	BICYCLE
Baseline Road & Priest Drive	4:15 PM	121	110	11
Baseline Road & Hardy Drive	4:15 PM	83	72	11
Baseline Road & Darrow Drive	4:15 PM	60	52	8
Baseline Road & Arizona Mills South	3:30 PM	56	51	5
Baseline Road & 48th Street	4:30 PM	48	45	3
Baseline Road & Calle Los Cerros Drive	4:45 PM	16	12	4
Baseline Road & Arizona Grand Parkway	4:45 PM	16	13	3
Baseline Road & I-10 NB Ramp	3:30 PM	16	14	2
Baseline Road & I-10 SB Ramp	4:45 PM	15	9	6
Baseline Road & Wendler Drive	4:45 PM	3	2	1

Figure 22 – Existing Crosswalk Traffic Volumes – Peak Hour of Crosswalk

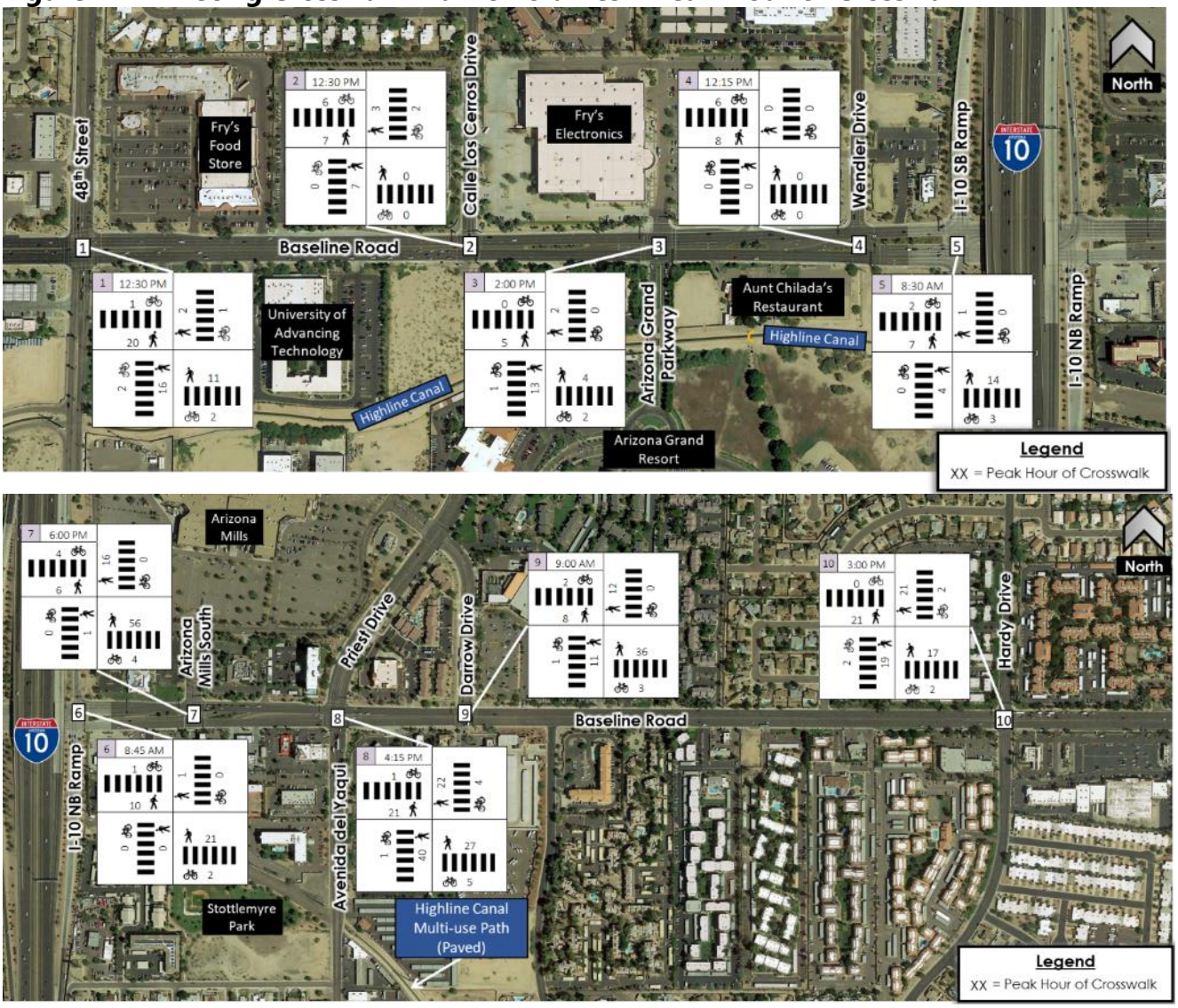
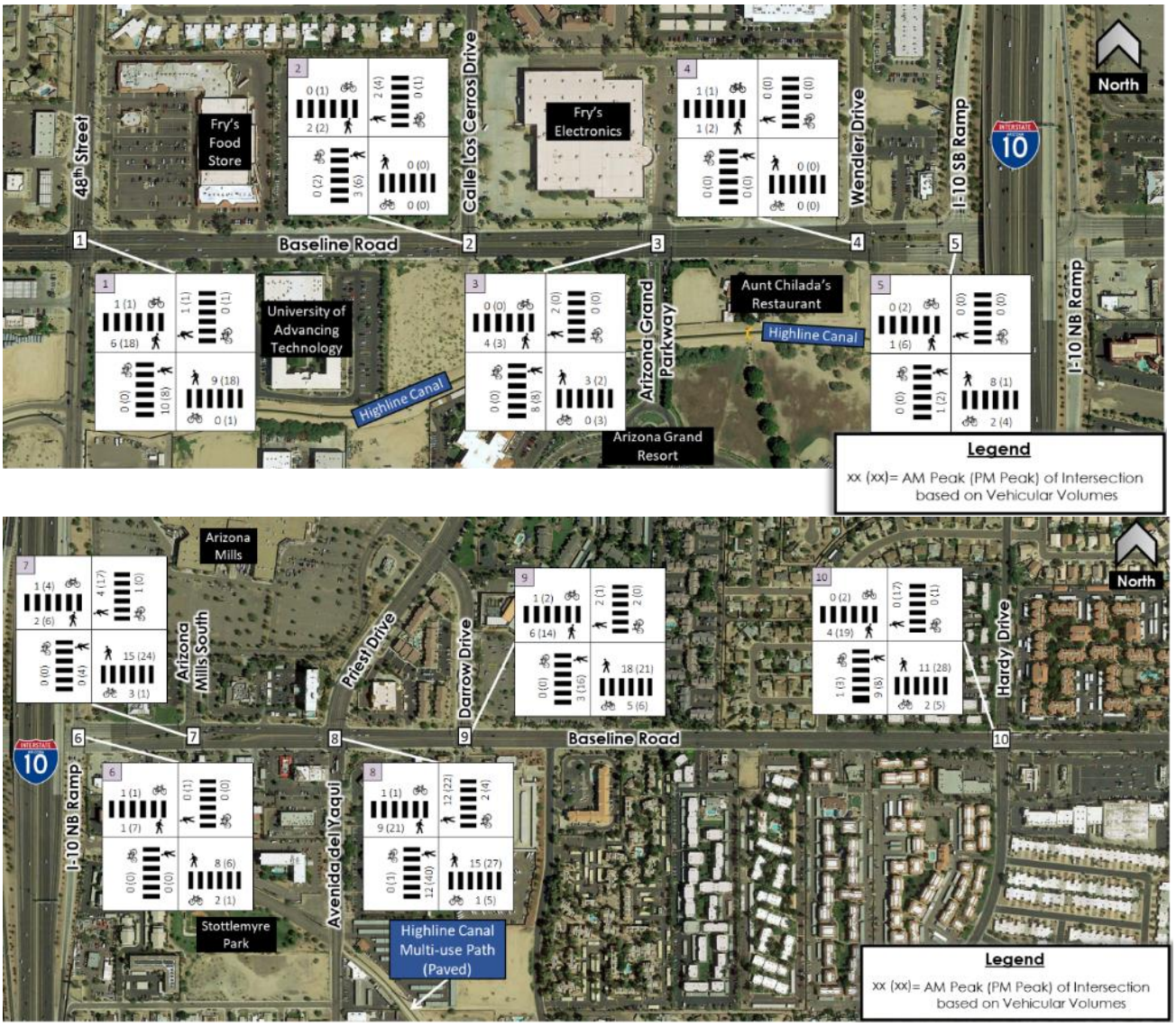


Figure 23 – Existing Crosswalk Traffic Volumes – Peak Hour of Intersection based on Vehicular Volumes



2.5 Operational Analysis Methodology

MAG Travel Demand Model data, discussed in **Section 2.5.1**, was obtained for the Study Area for existing (2018) and future year (2040) scenarios. The data provided the existing and future ADT volumes necessary for traffic forecasting, a process which provided calibrated future ADT volumes and turning movement counts for the peak a.m. and p.m. periods, discussed in **Section 2.5.2**.

Then, Synchro (Version 10.0) models were developed for a Level of Service (LOS) analysis of existing and future no-build conditions within the Study Area. A microsimulation model was developed using PTV Vissim (Version 10) software for the future condition to supplement the Synchro analysis. Operational needs and potential improvements were identified using the future no-build models, then assessed with future build condition models. This process is discussed in more detail in the following sections.

2.5.1 MAG Travel Demand Model

The MAG Travel Demand Model (TDM) is a regional 4-step model maintained by MAG and developed using the travel demand modeling software TransCAD. The Study Area lies completely within the MAG TDM, which was a critical tool to this Study for the development of future ADT projections and refined future turning volumes.

A TDM is often referred to as a "regional" model because the roadway network it represents typically spans multiple jurisdictions. TDMs are extensively calibrated and rooted in survey-informed population, employment, and socioeconomic data—all of which influence trip generation and mode choice. The MAG model has a land use component that includes socioeconomic information in the region disaggregated by a traffic analysis zone (TAZ). Each TAZ in the region includes information about housing, population and employment. Land use estimates for the future are generally derived from Census data and regional estimates associated with improvements. To develop the future year land use data, MAG utilizes the land use elements of adopted general/comprehensive plans for cities and towns in the region. Future year MAG models also include all programmed and funded roadway improvements in the region. Therefore, model traffic projections consider planned improvements, new developments, and land use changes expected by a specified horizon year. For this project, the only major difference in the 2018 and 2040 MAG model roadway networks within the Study Area extents is the configuration of the I-10 and Baseline Road TI. In 2018, the configuration is a standard diamond interchange. In 2040, the configuration is a DDI.

2.5.2 Traffic Forecasting

Future ADT and turning movement volumes for the Study Area were projected using forecasting methodology presented in *NCHRP 765 Report: Analytical Travel Forecasting Approaches for Project-Level Planning and Design*. The report and procedures outlined in the NCHRP 765 report largely derive from and improve upon the procedures outlined in a prior NCHRP publication, *Report 255: Highway Traffic Data for Urbanized Planning and Design*. The specific procedure used in the current study is an iterative turning movement estimation method which uses the combined Factoring Procedures for Ratio and Difference Methods in the NCHRP 765 Report.

The inputs required for post-processing model estimates using this method are:

- Base year traffic counts;
- Base year regional TDM estimates;
- Future year regional TDM forecasts; and.
- Design hour 30th highest K-factor.

The procedure adjusts the model forecasted link volumes using an iterative method to determine future turning movement volumes, using existing turning movement counts as a basis. A tolerance of 10 percent was used to determine the convergence of the iterative method. The iterative process is designed to minimize the errors identified in the existing year model estimates when compared to the observed traffic counts.

2.5.3 Synchro Model

Synchro (Version 10.0) models were developed for LOS analyses of existing and future conditions within the Study Area.

LOS is a qualitative measure of how well an intersection or roadway segment operates on a graded scale of A (best) to F (worse). LOS considers a variety of factors, including stability of traffic flow, opportunity for passing, and driver comfort. Operations of LOS D and better are typically considered acceptable in urban settings. Operations of LOS E or F may be flagged for improvement. For intersection analysis, LOS is determined using the total delay, in seconds, of vehicles which approach the intersection over the course of one traffic signal cycle. Intersections within the Study Area were analyzed using the LOS thresholds shown in ***Table 14***.

Table 14 – LOS Thresholds for Signalized Intersections	
Control Delay	**Level of Service**
≤ 10 seconds	A
10 – 20 seconds	B
20 – 35 seconds	C
35 – 55 seconds	D
55 – 80 seconds	E
> 80 seconds	F

The LOS analysis was conducted using Synchro's built-in methodology. While *Highway Capacity Manual (HCM) 6th Edition* methodology is most commonly used to assess intersection LOS, it cannot assess intersections with unique signal timings or geometric configurations.

Timing plans for the ten intersections were provided by the cities of Tempe and Phoenix to analyze existing (2019) conditions. Heavy vehicle percentages were computed from collected traffic count data and updated by approach. Crosswalk counts were incorporated in Synchro as pedestrian conflicts (number/hour).

Timing plans were optimized in Synchro for future (2040) conditions. Signal cycle length was optimized for between 90 and 120 seconds; coordination was optimized, as well. Yellow and red times remained unchanged from existing conditions.

2.5.4 Microsimulation Modeling

A microsimulation model was developed for the project Study Area using PTV Vissim (Version 10) software to provide a detailed assessment of traffic patterns in the Study Area. A microsimulation model is a detailed model, able to depict lanes, turn bays, parking, crosswalks, ramp meters, signals, and other physical characteristics of a network as one might see them in aerial imagery. It also allows the user to fine-tune a wide range of non-physical characteristics of the network, including signal timing, priority, and speed decisions. The same signal timing plans used in Synchro, discussed in **Section 2.5.3** were implemented in this microsimulation model. The microsimulation model was run for future a.m. and p.m. scenarios.

2.6 I-10 and Baseline Road TI

Planning level analysis and design were performed to evaluate alternatives. The goal of improving intersection operations was weighed against the constraints of matching proposed improvements to I-10 off ramps, salvaging the existing I-10 structure over Baseline Road, and maintaining access to the Arizona Mills intersection. Cost estimates were developed for all alternatives that had geometrics drafted.

Itemized cost estimates for each alternative are included in **Appendix D**.

Exhibits depicting the alternatives are included in **Appendix E**.

All build alternatives improve capacity and should therefore decrease the frequency of the congestion related rear end collisions.

Active Transit Considerations

The active transit considerations are to be implemented on any build alternative. The costs for the improvements are included in the cost estimates for the build alternatives.

Per the Tempe Public Works Engineering Design Criteria (May 2015), sidewalks are required adjacent to both sides of all city streets. Arterial streets require 8’-0” wide sidewalks, L-1 streets require 5’-6” wide sidewalks, and all other streets require 6’-0” wide sidewalks. Sidewalks and pedestrian paths shall be built in compliance with ADA requirements, and a minimum 8’ x 8' concrete clear area adjacent to the curb shall be required at all bus stops. Bus stops in areas with sidewalks less than 8' wide or with sidewalks separated from the curb shall be upgraded to meet the minimum clear area per City policy.

Appropriate quality and placement of lighting can increase comfort and safety at pedestrian crossings. Pedestrians need to be adequately illuminated to the approaching motorists. Any infrastructure improvements at the intersections should consider the visibility of pedestrians at the crossings and driveways.

A north-south shared-use path is shown in the alternatives between I-10 and Arizona Mills mall to permit cyclists and pedestrians traveling along Baseline Road access to the proposed Western Canal path extension and I-10 crossing. The Western Canal path extension and I-10 crossing will be constructed as part of the ADOT I-10 Broadway Curve improvements and will connect the Western Canal path crossing at Priest Drive with the Western Canal path near Wendler Drive.

The north side of Baseline Road is the preferred location to connect to the north-south shared-use path and the Baseline Road intersection with Priest Drive. With this connection, improved pedestrian facilities are required on the north side of Baseline Road along the route. The preferred design includes a pedestrian sidewalk, landscape buffer, and a bicycle path (allowing contraflow travel). If a separated bicycle path is not provided, signs will be required to allow contraflow riding, so it is not in conflict with Tempe's Ordinance No. O2017.05, and the width should align with shared-use paths. Design requirements for shared-use paths are provided in Tempe Standard Detail T-656. Per detail T-656, the minimum path width is 10 feet with a recommended path width of 12 feet. The proposed 2020 update of the AASHTO Guide for the Development of Bicycle Facilities has not yet been published; however, may provide new standards and guidance that should be incorporated during final design.

2.6.1 No Build

This alternative analyzes the no build conditions. Future volumes are analyzed with existing signal timings.

The existing ramp intersections at I-10 and Baseline Road are signalized. There is a crosswalk with a median refuge on Baseline Road at each intersection. Crosswalks are also provided crossing each ramp. The existing ramp intersections at I-10 and Baseline Road experience heavy conflicting right-turn vehicle volumes impacting pedestrian crossings, and vehicle queues currently block the crosswalks on Baseline Road during peak periods. The existing infrastructure is not in full compliance with ADA and PROWAG guidelines.

In 2040 the existing intersections operate at the LOS as indicated in ***Table 15***. Several intersections in the study corridor operate at a poor LOS due to a combination of increased traffic volumes and poor coordination.

Table 15 – No-Build Intersections 2040 LOS

Intersection	A.M. Peak Hour LOS	P.M. Peak Hour LOS
Arizona Grand Pkwy/Wendler Dr	F/E	D/D
Baseline Rd & EB Ramp	E	F
Baseline Rd & WB Ramp	E	E
Arizona Mills	A	B
Priest Dr	E	D

2.6.2 Standard Diamond

This alternative analyzes a modified standard diamond interchange. An additional right turn lane is added for both the Eastbound and Westbound I-10 on-ramps. At the I-10 TI, storage lengths are increased for all approaches. The lane configuration underneath the I-10 bridge remains unchanged and does not impact the I-10 bridge over Baseline Road. Raised median is present along Baseline Road, with breaks at signalized intersections, including Calle Los Cerros, Arizona Grand Parkway, I-10 WB, I-10 EB, Arizona Mills, and Priest Drive. All other access points within the corridor are modified to right-in right-out (RIRO).

The existing I-10 structure over Baseline Road is preserved. Access to adjacent businesses, including Aunt Chiladas, TitleMax, Harvest, and Waffle House will need to be reconfigured. Access to Aunt Chiladas is proposed to be relocated to Arizona Grand Parkway.

The standard diamond alternative provides crosswalks at the ramps and across Baseline Road similar to existing conditions with improved refuge islands and sidewalk ramps. The standard diamond alternative is expected to improve operation potentially decreasing the vehicle queues that currently block the crosswalks. The conflicting right-turn vehicle volumes would continue to impact the pedestrian crossing experience. An improved sidewalk on the north side of Baseline Road with a connection to a new shared-use path is proposed with this alternative. New improvements will be built in compliance with the ADA and PROWAG guidelines.

<u>Wendler Realignment</u>

Due to the proximity of Wendler Drive to the I-10 Eastbound ramp intersection, the roadway alignment will need to be modified to improve operations within the corridor. Along Wendler Drive, 600 feet north of Baseline Road, Wendler Drive will curve west and intersect Baseline Road in line with Arizona Grand Parkway. The realignment will impact parking for Fry's Electronics by dividing the parking lot in half. Measures will need to be taken to ensure there is safe pedestrian crossing along Wendler Drive.

Access at Old Wendler Drive is modified to a RIRO to provide access to restaurants on the NWC and NEC of Baseline and Wendler. The existing Wendler Drive signal is removed.

The intersection LOS are displayed in ***Table 16***.

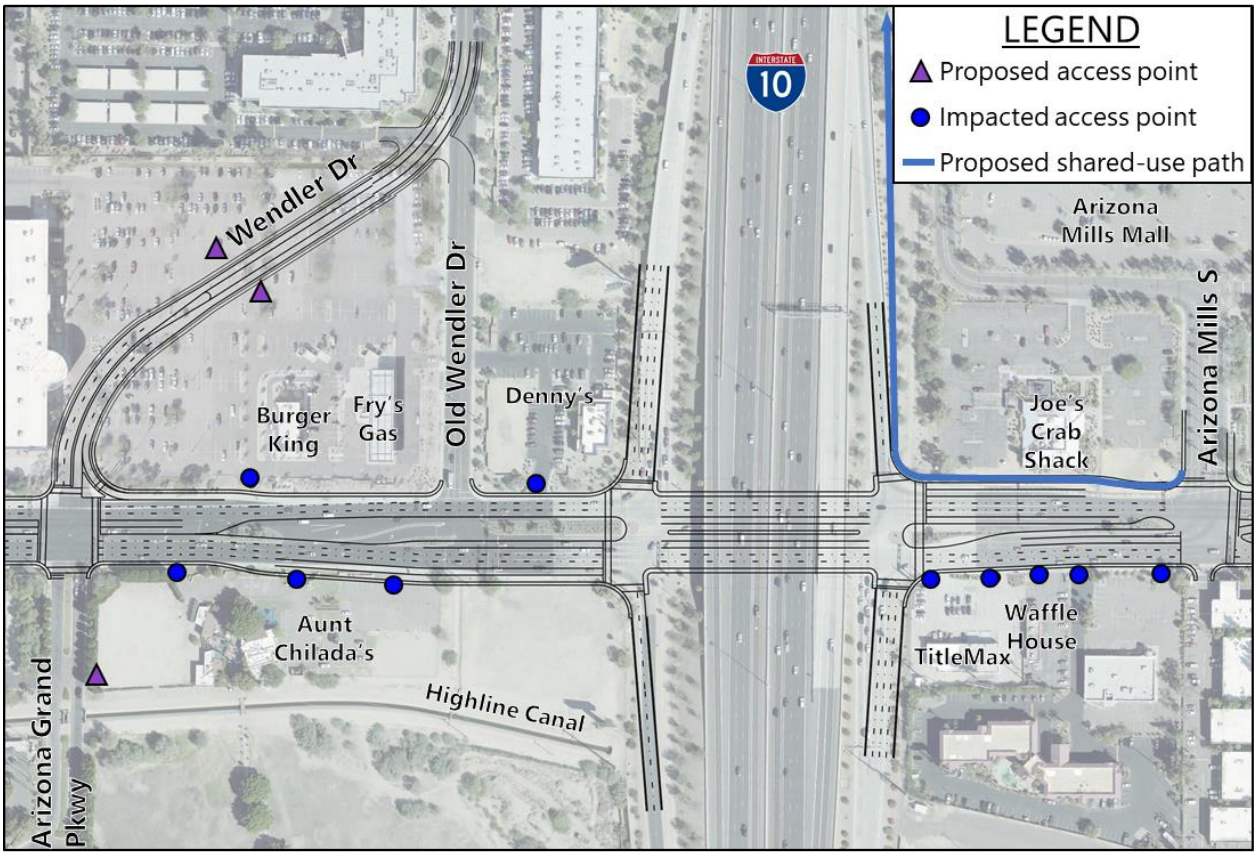
Table 16 – Standard Diamond Intersections 2040 LOS		
Intersection	**A.M. Peak Hour LOS**	**P.M. Peak Hour LOS**
Wendler Dr/Arizona Grand Pkwy	C	B
Baseline Rd & EB Ramp	B	C
Baseline Rd & WB Ramp	C	C
Arizona Mills	A	C
Priest Dr	D	D

The estimated cost of this alternative is $13,100,000, which does not include costs for utilities and right-of-way needs. The estimated cost is in 2019 dollars. The cost estimate includes design services and construction items. The cost estimate is included in **Appendix D**.

Developing right-of-way costs, including but not limited to real property acquisition, relocation costs, and costs to cure, should be an emphasis of the next step of the project development.

Intersection improvements at I-10 are shown in ***Figure 24***. Location of proposed access points will be determined during final design in conjunction with the right-or-way acquisition process. Disposition of the impacted access points will be determined during final design while coordinating with impacted landowners. For the full design of this alternative, see **Appendix E.**

Figure 24 – Baseline Road TI Standard Diamond



2.6.3 Diverging Diamond Interchange (DDI)

This alternative analyzes a modified DDI with signalized ramps to and from I-10.

The existing structure over I-10 is preserved. Access to adjacent businesses, including Aunt Chiladas, TitleMax, Harvest, and Waffle House, will need to be reconfigured. Denny's on the northeast corner of Baseline Road and Wendler Drive will be directly impacted.

A benefit of the DDI is the flexibility to have the turning movements from Baseline Road onto the eastbound entrance ramp operate simultaneously. All DDI entry and exit ramps are signalized to allow improved operations within the corridor.

The DDI alternative eliminates the north-south crosswalks across Baseline Road at the I-10 interchange ramps. The existing pedestrian counts crossing Baseline Road at the ramps are minimal. With this alternative, pedestrians could cross at the nearest signalized intersections east and west of the interchange (Arizona Mills and Arizona Grand Parkway). The proposed diverging diamond alternative provides signals at each ramp eliminating free flow right-turns, thus reducing crash risk and providing a more comfortable crossing for pedestrians travelling east-west. An improved sidewalk on the north side of Baseline Road with a connection to a new shared-use path is proposed with this alternative. New improvements will be built in compliance with the ADA and PROWAG guidelines.

<u>Wendler Realignment</u>

Due to the proximity of Wendler Drive to the I-10 Eastbound ramp intersection, the roadway alignment will need to be modified to improve operations within the corridor. Along Wendler Drive, 600 feet north of Baseline Road, Wendler Drive will curve west and intersect Baseline Road in line with Arizona Grand Parkway. The realignment will impact parking for Fry's Electronics by dividing the parking lot in half. Measures will need to be taken to ensure there is safe pedestrian crossing along Wendler Drive.

Access at Old Wendler Drive is removed as it intersects with the I-10 Eastbound off-ramp before it has reached Baseline Road. The existing Wendler Drive signal is removed.

The intersection LOS are displayed in ***Table 17***. Each approach is forecasted to operate at a passing LOS.

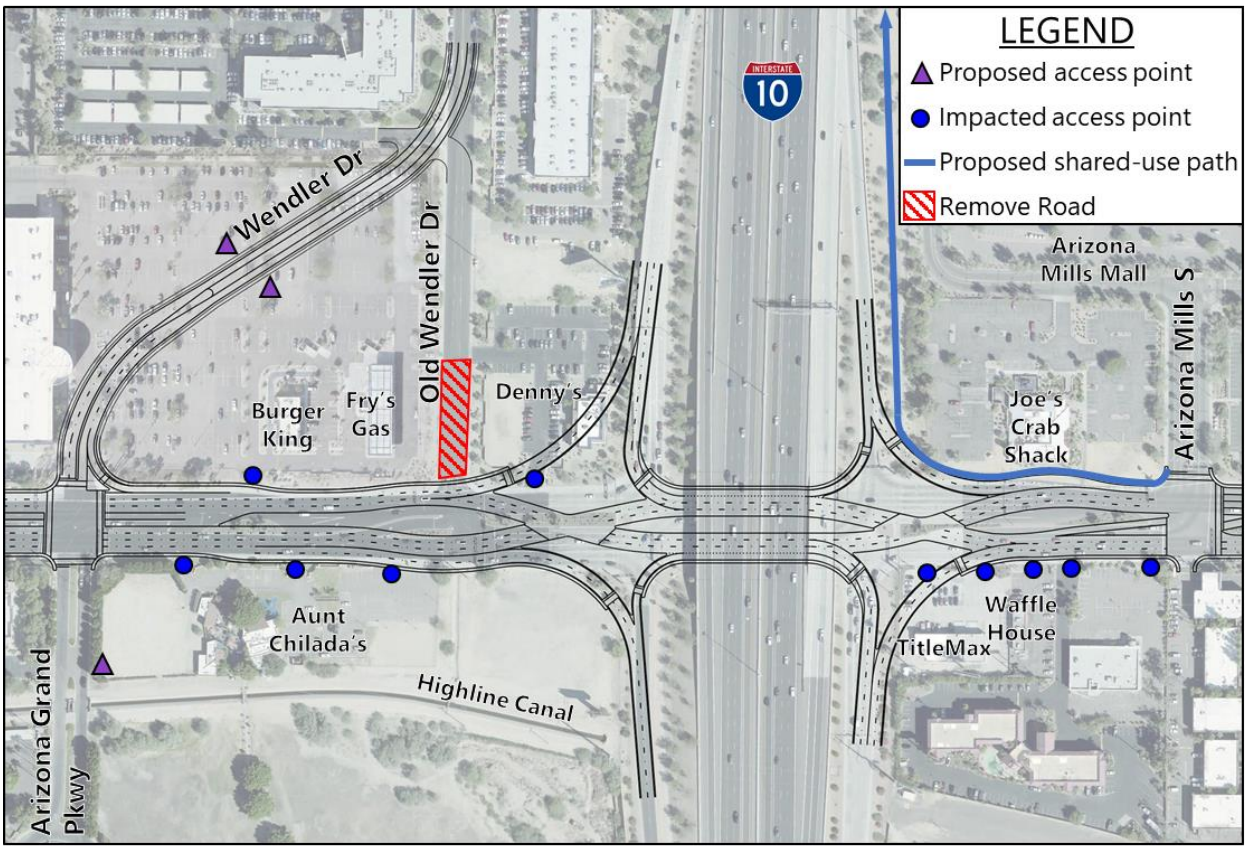
Table 17 – DDI A.M. and P.M. Peak Hour LOS		
Intersection	**A.M. Peak Hour LOS**	**P.M. Peak Hour LOS**
Wendler Dr/Arizona Grand Pkwy	C	C
Baseline Rd & EB Ramp	C	C
Baseline Rd & WB Ramp	B	B
Arizona Mills	A	A
Priest Dr	D	D

The estimated cost of this alternative is $14,300,000, which does not include costs for utilities and right-of-way needs. The estimated cost is in 2019 dollars. The cost estimate includes design services and construction items. The cost estimate is included in **Appendix D**.

Developing right-of-way costs, including but not limited to real property acquisition, relocation costs, and costs to cure, should be an emphasis of the next step of the project development.

Intersection improvements at Baseline Road are shown in ***Figure 25***. Location of proposed access points will be determined during final design in conjunction with the right-or-way acquisition process. Disposition of the impacted access points will be determined during final design while coordinating with impacted landowners. For the full design of this alternative, see **Appendix E.**

Figure 25 – Baseline Road TI DDI



2.6.4 Continuous Flow Intersection

Analysis for the Continuous Flow Intersection (CFI) conceptual alternative was carried out in Vissim. Operational analysis revealed that queuing between ramp terminal intersections and between the westbound ramp terminal intersection and Arizona Mills intersections to be excessive. The excessive queuing was the result of:

1. Inadequate storage space for vehicles between the closely spaced intersections and;
2. Poor progression through the corridor due to the non-conventional signal phasing of the CFI concept and traditional phasing patterns in proximity.

A cost estimate and figure were not prepared for the CFI alternative due to flaws in operations and geometry.

3.0 Summary of Alternatives

Table 18 provides a summary of the improvement alternatives investigated for the I-10 Baseline Road TI. A detailed evaluation matrix is provided in **Appendix F.**

Table 18 – Summary of Alternatives

Alternative	Cost*	Notes
Standard Diamond	$13.1M	• All intersections operate at acceptable LOS in design year. • Impacts to businesses at EB and WB ramps. • Old Wendler Drive transformed to RIRO
Diverging Diamond Interchange	$14.3M	• All intersections operate at acceptable LOS in design year. • Total take of Denny's and impacts to other businesses. • Full closure of Old Wendler Drive intersection.
No-Build	See ***Table 19*** for user delay cost	• All intersections besides Arizona Mills operate at LOS D or worse in both a.m. and p.m. peak in design year. • Crash frequency likely to increase with increased congestion.
Continuous Flow Intersection	-	• Not evaluated further due to design and operational fatal flaws.

*The cost estimates are in 2019 dollars. The cost estimates include design services and construction items. Utilities and right-of-way costs are not included and will need to be identified. The cost estimates are included in **Appendix D**.

Table 19 displays the projected user delay and volumes serviced for each alternative in the design year for the major movements, including:

- Baseline Road EB to I-10 EB and WB ramps;
- Baseline Road WB to I-10 EB and WB ramp; and
- Baseline Road through movements in both directions between Arizona Mills and 44th Street.

The serviced volume may be lower than the projected demand if the alternative experiences congestion as indicated by the LOS at individual intersections. An average user wage rate was determined utilizing the ADOT Road User Cost formula.

In the design hours, the standard diamond and DDI service approximately the same volumes and have similar calculated user costs. The no-build scenario average cost per user is 2 to 3 times more compared to the proposed build alternatives. A detailed breakdown of the user cost and projected volumes for all alternatives is found in **Appendix G**.

Table 19 – 2040 Design Hours' Projected Volumes and User Cost

Alternative	Major Movement Serviced Volume		Major Movement User Cost		Average Cost Per User	
	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
No-Build	3,025	1,644	$4,200	$3,400	$1.39	$2.07
Standard Diamond	3,704	2,828	$2,500	$2,120	$0.67	$0.75
DDI	3,730	2,844	$2,600	$2,000	$0.70	$0.70

Alignment with Vision Zero

Vision Zero is a traffic safety policy that takes an ethical approach towards achieving safety for all road users. Tempe is the first Vision Zero city in Arizona. The active transportation improvements proposed with the standard diamond and diverging diamond alternatives align with Vision Zero Tempe's Pedestrian and Bicycles and Scooters action areas by improving existing infrastructure and connectivity. Infrastructure improvements include compliance with ADA standards, improved sidewalks, access management, lighting, and connection to a future grade separated crossing of I-10. The diverging diamond alternative also supports the Intersection action area. Vision Zero is rooted in the shared responsibility among system designers and policymakers to design and operate safe systems for transportation. The following transportation safety strategies should continue to be implemented in future design and construction phases of this project:

- Int.1 Identify intersections for low cost pedestrian and bicyclist safety countermeasures (e.g. pavement markings, signal timing, signs);
- Int.2 Identify intersections that could benefit from converting to protected left turns;
- B.2 Coordinate bicycle and pedestrian expert reviews of project designs;
- P.1 Develop guidelines for installation of high visibility crosswalks (May include shared-use path crossings and school areas);
- P.2 Identify corridors that could benefit from the installation of raised medians and pedestrian refuge islands;
- P.3 Identify locations with excessive pedestrian delay at signalized intersections and examine opportunities to improve pedestrian wait time;
- P.4 Identify locations that could benefit from grade separated pedestrian crossings. (Connection to a future grade separated crossing of the I-10 is identified in this study.); and
- Imp.3 Continue to and expand engagement with businesses and establishments that serve/provide alcohol and drugs (pharmacies, medical marijuana dispensaries) to be an increased part of the solution. (A marijuana dispensary exists on the southeast corner of I-10 and Baseline Road.)

4.0 Conclusion

This study identified that the Standard Diamond and DDI, along with the realignment of Wendler Drive, improve operations and should be advanced for further development. These alternatives enhance regional travel and mitigate safety issues.

The following is a general list of steps that should be taken to implement the study findings:

Complete Feasibility Study of Adjacent Intersections – The existing conditions analysis determined that the number and proximity of traffic signals, the condition of the active transportation infrastructure, and the types of access control along Baseline Road between 48th Street and Hardy Drive contribute to operational and crash challenges within the corridor. At the Planning Partners' direction, this study focused the proposed improvements on the I-10 TI area and provides recommendations for geometric improvements between Calle Los Cerros Drive and Priest Drive. Operations along Baseline Road, including at the TI, would benefit from improvements at the adjacent intersections of Baseline Road and 48th Street, Calle Los Cerros Drive, Darrow Drive and Hardy Drive.

Implement Independent Utility Improvements – There are several proposed improvements that are common with both the Standard Diamond and DDI alternatives and do not directly interface with the Baseline Road TI Ramps. These improvements can be designed independently of the TI improvements themselves and can be constructed to provide users immediate benefit. Qualifying improvements include:

- Optimize signal timings along the corridor through multiagency coordination with Tempe, Phoenix, and ADOT;
- Realignment of Wendler Drive to the west and removal of the existing Wendler Drive signal with Baseline Road; and
- Pedestrian and bicycle improvements, specifically the two-way shared-use path on the northside of Baseline Road between I-10 and Priest Drive and on the east side of I-10.

Incorporate Preferred Concepts into Existing and Future Studies and Planning Documents – Involved agencies should include the study findings in future planning and project development efforts. Any future changes should still address the underlying issues identified by this study, accommodate the proposed ADOT

I-10 Broadway Curve improvements, align with Vision Zero practices, and not preclude BRT along Baseline Road.

Complete Scoping Phase (Design Concept Report) – The concepts should be carried forward as Design Concept Alternatives in the project development process. ***The geometric recommendations are conceptual in nature; the formal scoping process will need to be completed, including required typical local, state, and federal agencies approvals.*** Use of the information contained herein for right-of-way acquisition and similar activities is not recommended until the appropriate time during the project development process. Potential additional Design Concept Alternatives that may surface through the process should be consistent with the operational and access goals of this study. The concepts herein considered the recommended alternative identified in the MAG I-10/I-17 Spine Corridor Master Plan (March 2018). As part of the formal scoping process, the geometric recommendations for the I-10 and Baseline Road TI should consider any updates of the planned I-10 corridor improvements. It is recommended that the planning partners continue coordination throughout the Scoping Phase.

A focus of the scoping phase should be to generate right-of-way costs, including but not limited to real property acquisition, relocation costs, and costs to cure.

Prior to the final design of any improvements, additional investigation and analyses should be conducted, including necessary environmental/NEPA evaluations, geotechnical investigations, and others.

Project Funding – Funding for project development and construction need to be identified.